OULU BUSINESS SCHOOL
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HEDGE FUND STRATEGIES, RISKS AND BENCHMARKING DURING SEVERAL FINANCIAL CRISES

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ABSTRACT OF THE MASTER'S THESIS

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Abstract

The goal of this Master´s thesis is to compare and understand different types of hedge fund strategies, the risks, and returns included within hedge funds, and how hedge funds can be benchmarked against the market returns. In addition to this, the performance of hedge funds during crises is evaluated. The main risks that this thesis addresses regarding the hedge funds industry are systematic risks, credit risks, tail risks, liquidity risks, and other risks embedded within the hedge fund industry. Several main crisis periods are defined in this study, namely the crises of 1998, 2001, 2008, and 2020 and the overall time period included in this thesis is between January 1997 and November 2020.

Hedge funds are described as alternative investment methods. What makes them alternative compared to traditional investment methods (such as investing in stocks and traditional funds) is the ability to follow and apply unconventional trading strategies such as futures, swaps, options and, arbitrage. One particular trait of hedge funds is the ability to reach different types and levels of risks through various exposures to markets, combined with different betas and alphas. The principal data employed in this thesis is obtained from BarclayHedge and the model applied to study the return movements of hedge fund strategies against the market returns is the capital asset pricing model. Main research questions within this thesis pursue to answer a) whether overall hedge fund performance is market neutral and positive even during the periods of financial turmoil, b) whether hedge funds are able to capture excess alpha and differentiated beta exposures during financial crises, c) furthermore, this thesis pursues to answer questions concerning genuine risks affecting hedge funds´ ability to create value and gain profits.

The results indicate that when compared to normal time periods, most hedge fund strategies are in fact not able to create statistically significant excess alpha during several financial crises. Furthermore, even though measurements of hedge fund neutrality such as beta coefficients and correlation are seemingly small during times of market tranquillity, values increase promptly during financial crises. Therefore, questioning the neutrality of hedge fund strategies and the actual level of hedging during financial crises is in place.

Keywords
Hedge funds, liquidity, risks, returns and benchmarking, financial crises

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1 INTRODUCTION

What makes the hedge fund industry so intriguing to me that I would choose to write a thesis about this topic? As I wrote my bachelor´s thesis about stock-portfolio diversification and the risk tolerance that affects the investors desire to invest and diversify, I thought that pursuing a master´s thesis about more industrial and complex investing strategies would give me a more comprehensive outlook on the whole investments industry. Hedge funds have also gained a lot of attractivity in the past two decades and extensive studies about this topic are increasingly more common. Bali, Gokcan, and Liang (2007) point out that the astounding recent popularity gained by hedge funds is mainly due to the low correlations with traditional asset classes such as mutual funds, a light regulation, flexible trading strategies, and an advantageous fee structure.

The implication within the term “hedging” is the reduction of risk, hence the term “hedge against risk”. Risks faced by an investor could be those related to inflation, or fluctuations of stock markets, oil price or for instance foreign exchange rates. A perfectly hedged situation implies the outcome of not risk at all. (Hull, 2018, p. 49). A perfectly hedged situation can for instance be achieved when an asset or an investment object is entirely negatively correlated inside the portfolio and therefore reduces the portfolio variance to a minimum (Bodie, Kane & Marcus, 2014, p. 234). Adrian, Brunnermeier, and Nquyen (2011) add in this context that the hedge fund sector has become one of the crucial elements of the market-based financial systems, and even though during tranquil market conditions hedge funds provide liquidity provisions and advanced returns, during times of market turmoil and crises, hedge funds can be forced to deliver, which might contribute to the overall market volatility and other poor outcomes.

Hedge funds are well known for their usage of hedging, derivatives, arbitrage, and speculation. Similar to mutual funds, hedge funds also invest on behalf of customers (Hull, 2018, p. 12). What differentiates them from classical mutual funds is that they offer their services only to institutional investors such as endowment funds, pension funds, or prosperous individuals, whereas mutual funds also offer their securities in a

more public manner (Bodie et al. 2014, p. 13). Mutual funds are also more prone to regulations regarding the liquidation of investments, investment policies, and usage of leverage that are relatively loosely regulated within hedge funds. Their freedom from strict regulations allows hedge funds the independence to employ unconventional, complex, and sophisticated investment strategies. (Hull, 2018, p. 12). Fung and Hsieh (1999) argue that the difference in return aspects between mutual funds and hedge funds can be explained by differences in trading strategies. Hedge funds can use dynamic trading strategies whereas typical mutual funds operate with methods that can be defined as static buy-and-hold strategies. What also further widens the gap between these funds, is the ability for hedge funds to use leverage through the use of for instance short sales, usage of derivatives, and different investment strategies (Zhan, 2011). Whereas the use of leverage for mutual funds is often limited or even restricted. Therefore, the regulation and jurisdiction of hedge funds also work differently. The compensation systems for hedge fund managers vary between mutual funds as well. (Fung & Hsieh 1999.) Bodie et al. (2014, p. 96) continue to argue that, as hedge funds are structured rather as private partnerships and therefore accountable to less regulation by the Securities Exchange Commission (SEC).

Due to this lack of regulations, hedge funds have been under a rising level of supervision after the devastating events of 2008. For research purposes the main financial crises or market downfalls in 1998, 2001, 2008, and 2020 offer an interesting opportunity to study different hedge fund strategies and their success or failures during times when market conditions are extremely insecure and falling. The objective of this thesis is to evaluate different hedge fund strategies, their risks, and returns or losses, and benchmarking during crisis periods and comparison periods. This evaluation is done to answer the main research question: how do hedge funds succeed when compared to market returns during several financial crises and how success is determined by the strategy that the hedge fund is practicing?

Hedge funds can leverage themselves pretty much to the extent they wish, and their fee structure differs vastly compared to a normal investing advisory and to mutual funds. According to Liang (2000), hedge funds are described as alternative investment instruments. Other alternative investment options include mainly private equity, real assets, and structured products. In order to analyze hedge funds and alternative

investments, the distinction between traditional and alternative assets first needs to be clarified.

Hedge funds can leverage themselves pretty much to the extent they wish, and their fee structure differs vastly compared to a normal investing advisory and to mutual funds. According to Liang (2000), hedge funds are described as alternative investment instruments. Other alternative investment options include mainly private equity, real assets, and structured products. In order to analyze hedge funds and alternative investments, first, the distinction between traditional and alternative assets first needs to be clarified.

Nowadays, in the 21st-century, traditional investments mainly include equities (like corporate stocks) and investment-grade bonds (the debt that is issued by corporations and the government). On the other hand, "alternative" investing includes the distinctive following features. First of all, investment returns are driven by the exposure to assets with nontraditional cash flow - for instance venture capital, life insurance contracts, farmland and even art, which renders returns less correlated with returns from stock markets. The second feature is that alternative investment returns are often driven by complicated trading strategies that involve leverage, financial derivates and short sales, which cause them to gain unusual risk-exposures and flexibility. The third main characteristic of alternative assets is that investment returns are built in a way that they generate nontraditional payouts (such as in collateralized debt obligations or CDOs). So, when comparing traditional-, and alternative investments, what combines these three features is the distinct case of investments returns. Alternative asset returns do not follow the returns of traditional asset classes, which means that they need more specialized methods of analysis. Therefore, alternative investing opportunities may help an investor reduce their risk through diversification, enhance returns through alpha, and avoid obsolescence. (Chambers, Black & Lacey, 2018, pp. 5–6.)

This research will mainly focus on hedge funds, since they are the most commonly used option for performing investing in alternative investments. The popularity of hedge funds has risen remarkably ever since the first hedge fund was introduced in 1949 (Caldwell 1995). As of the 3rd Quarter 2020, the total of the assets under

management (AUM) for the entire hedge fund industry amounts to approximately $3379.6 billion (Barclay Hedge 2020). Additionally, Patton (2009) gives a perspective to the growth of the hedge fund industry by comparing hedge fund assets under management in 1990 ($50 billion) and in 2004 ($1 trillion).

The main focus of this thesis is to analyze the performance of different hedge fund strategies against market returns during bullish, average, and bearish market conditions over the time period from 1997 until 2020. Main research questions within this study pursue to answer, a) whether overall hedge fund performance is market neutral and positive when compared to market returns even during the periods of financial crises, b.) are hedge funds able to capture excess alpha and differentiated beta exposures during financial crises, or are all hedge funds just as correlated with market returns as traditional investment vehicles are, c.) besides, this thesis pursues to answer questions concerning genuine risks affecting hedge funds' ability to create value and gain profits.

The data used within this study is obtained from BarclayHedge and includes monthly data of different hedge fund strategy returns between the period of January 1997 and November 2020. To create an as versatile preview of hedge funds as possible, 18 different hedge fund indices strategies returns are compared against market returns that are defined by FF3- factors and proxied by the commonly used risk-free indicator of one-month U.S government T-bill rate. (French, 2020). One strategy out of these 18 allocations is known as the “Barclay Hedge Fund Index” which is included for the sake of comparison, representing the entire hedge fund industry captured by the database BarclayHedge. In the course of this thesis, it will be discussed as part of the 18 hedge fund strategies as it is one general option for performing hedge fund investing as well, even though it is a combination of all different hedge fund strategies rather than a simple distinctive strategy itself.

The first model used in the analysis of hedge fund returns against market returns during the overall period of 1997 to 2020 is a single index model, the Capital Asset Pricing Model (CAPM). The second model employed in this study is an augmented version of CAPM which includes a crisis dummy (I_{CR}) and an interaction term between market returns and crisis dummy variables. The augmented version of CAPM is used in order

to capture the authentic differences in the alpha and beta of hedge fund strategies over the courses of several financial crises and during the average comparison periods between 1997 and 2020. The main financial crises affecting hedge fund returns and market conditions considered in this thesis are the crises in 1998, 2001, 2008 and 2020. The quantity of months of financial crisis during each crisis is based on the definitions introduced by Jiang and Kelly (2012), National Bureau of Economic Research (NBER, 2021), and Ding, Levine, Lin and Xie (2020).

Empirical results indicate that most hedge fund strategies are not able to create statistically significant excess alpha during several financial crises when compared to normal periods. Furthermore, even though hedge fund neutrality measures such as beta coefficients and correlation are seemingly small during times of market tranquillity, values increase promptly during financial crises. These results are in line with existing empirical literature on hedge fund performance such as presented by Billio, Getmansky Sherman and Pelizzon (2010).

This thesis proceeds as follows. Chapters 2, 3 and 4 form the theoretical part of this thesis, and include the implications concerning risks and characteristics influencing the overall success of the hedge fund industry during financial crises. Chapter 4 gives a detailed description of different hedge fund strategies, their implications, their tendencies during bullish or bearish market conditions, and also defines investing behaviours. Chapter 5 focuses on data-related topics including a comprehensive description of biases affecting hedge fund-related data, the methodology, and research methods employed within this thesis as well as the summary statistics computed as part of this thesis of hedge fund strategy returns and assets under management. Chapter 6 summarizes the main findings of this research and attempts to answer the research questions determined upon this thesis. Besides, the empirical performance of different hedge fund strategies' performance against market returns during financial crises and comparison periods are represented and analyzed to a great extent and amplitude.

2 HEDGE FUND RETURN AND RISK CHARACTERISTICS

There are many considerable practical issues when evaluating hedge funds. The risk profile of hedge funds - meaning their total volatility and their exposure to systematic risk factors- may change quickly, especially when compared to mutual funds, as hedge funds can alter their investment strategies opportunistically. The unsteadiness of hedge funds makes evaluating their exposure to certain risks difficult. Hedge funds heavily invest on illiquid assets; therefore, the true alpha of hedge funds needs to be distinguished from the liquidity premiums. Measuring the rates of returns can be difficult since the pricing of assets traded inactively is complex. Hedge funds also pursue strategies that may provide possible gains over a long period of time, while exposing the fund to uncommon but harsh losses. Therefore, estimating the true risk-return trade-off of hedge funds over long periods of time is necessary but difficult. Due to the ability of hedge funds to change their risk profiles, the manipulation of traditional performance determinants is also possible. (Bodie, Kane & Marcus, 2014, p. 853.)

According to Agarwal and Naik (2004), estimating hedge fund- related risks is important because many hedge funds propose a risk-free rate as a benchmark for calculating and claiming incentive fees. Chamber et al. (2018, p. 146) show that even though traditional investments are often perceived as connected to a normal probability distribution, alternative assets such as hedge funds tend to require rather more skill-based strategies. The possibility for extreme outcomes is much more present among alternative assets, and the process of measurement and management of the portfolio is not an easy task. The complexity in the context of hedge funds arises from different types of risk exposures and from natural conflicts, such as agent problems between hedge fund managers and their clients. (Chambers et al., 2018, p. 146.)

Khandani and Lo (2007) argue that credit and liquidity risk present the most common considerable risks among hedge funds. Even though they are considered as independent sources of risk exposures to investors and hedge funds, they are viewed as closely related by many investors after the problems experienced by LTCM and other similar hedge funds with fixed-income relative value during the financial crisis of 1998. Liang and Park (2010) show that factors such as age, size, performance and

lockup provisions provide good measurements for predicting possible hedge fund failures.

2.1 Systematic Risk

A risk that remains - even after significant level of diversification- is called a market risk, while a diversifiable risk is called a nonsystematic risk. Systematic risk factors originate from market-wide risks and are therefore often referred to as market risks (Bodie et al., 2014, p. 206). The risk profiles of hedge funds (their total volatility and systematic factors) may vary rapidly due to changes in their investment strategies - a fact which also makes continuous measuring of systematic risk exposures more difficult. (Bodie et al., 2014, p. 853).

A systematic risk is a risk that cannot be diversified, and it emerges from the correlation between the returns of the whole market and in this instance, the returns of a hedge fund. Generally speaking, investors that bear more systematic risks expect a higher compensation than a risk-free rate. (Hull, 2018, p. 128). The systematic risk of investments is usually measured by beta, which compares the sensitiveness of returns on specific investments to returns of the whole market. Muhtaseb and Colborn (2012) add that hedge funds usually pursue returns that are separate from the returns of the market, hence beta measures a security´s exposure to the market risk. If the calculated beta for an investment is one, it means that it follows market returns completely, whereas if it is zero, it means the asset's returns are not sensitive compared to returns exhibited in the market. (Hull, 2018, p. 75.)

In Figure number 1, n demonstrates the level of diversification inside an investment's portfolio on the x-axis, while on the y-axis, r demonstrates the lessening risk via added investment particles. From this graph we can notice that the systematic risk - or market risk- stays on a constant level, even when a portfolio is more diversified.

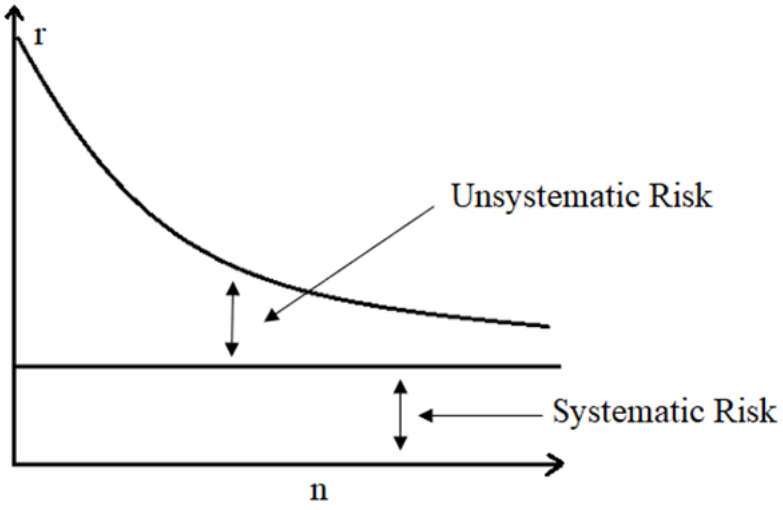

Figure 1. Systematic risk compared to unsystematic risk as the level of diversification arises (according to Bodie, Kane, Marcus & Mohanty 2014, 207)

Bali, Brown and Caglayan (2012) argue that contrary to the popular understanding that hedge funds are market neutral, the exposure of hedge funds to systematic risk explains the dispersion of cross-sectional returns more significantly than their exposure to tail risk and residual risk does. Furthermore, Bali et al. (2012) show that the systematic risk of individual hedge funds can be calculated as the difference between the total risk and the residual risk of hedge funds. In addition to this, they show that after controlling other hedge fund- related factors such as residual risk, age, size, incentive and management fees, lagged returns, lockup periods, minimum investment restrictions and leverage, all the results show a significant and positive relationship between the predictions of the hedge funds' future returns and the systematic risk. In some situations, the predictive capability in regard to systematic risk arises from the ability of hedge funds to detect shifts in financial markets, and their skills to adjust their positions timewise, whenever changes in economic or financial situations occur. (Bali et al., 2012.)

Brown, Hwang, In and Kim (2013) argue that the relationship between systematic risk and hedge funds is theoretically the correlation between real economic activities and hedge funds. Hedge funds pose a systematic risk to real economic activities by hampering the capability of financial markets or intermediaries to provide credit through many distinctive mechanisms.

Chambers et al. (2018, p. 63) point out that the traditional systematic risk factors concerning hedge funds are equity market risk, credit risk, and interest rate risk. One goal of hedge funds is to invest in different sets of systematic risk factors, and by doing so to achieve a better mixture of returns and risks. Bali et al. (2012) show that hedge funds within the highest systematic risk quintile generate on average of 6% more returns annually than the funds within the lowest risk quintile. Even when systematic risk factors are controlled, the relation between future fund returns and residual risk is insignificant. When the two main categorizations of hedge fund strategies are perceived, the effects of systematic risk effects increase as the strategy shifts from least directional strategies to most directional strategies, implying a much robust relationship among future returns and systematic risk for funds, with considerable time-series variation in systematic risk. (Bali et al., 2012.)

The recent financial crisis in 2007-2009 made some implications for reforming the regulation within the hedge-fund industry. Arguments for reforming the regulation originate mainly from the necessity to improve the protection of investors. But, since investor protection is not much related to systematic risk, the best way to deal with investor protection might not be the best way to deal with systematic risk. This implies that the systematic risk that hedge funds add to the international financial system is not addressed with the registration of hedge funds. Given the fact that hedge funds have started to play a significant role within the financial markets, they cause external effects on the economy that should not be neglected. Also, what poses a risk to financial markets in general is the fact that restraints of hedge fund liquidity can occur simultaneously within an entire sector, which can then potentially lead to catastrophic consequences for the entire financial system. (Khandani & Lo, 2007.)

2.1.1 Non-linear hedge fund risks

The need for using nonlinear methods emerges from the fact that linear factor models such as APT and CAPM, which are usually used as a foundation for empirical and theoretical asset pricing literature restrict the relationship between returns and risk factors as if they were linear. However, most hedge fund returns are not characterized as linear and therefore, in order to price securities correctly, a nonlinear function is

needed for the risk factors. Due to this nonlinear relationship, hedge funds are exposed to tail risk, which is hard to diversify. (Agarwal & Naik, 2004.)

According to Agarwal and Naik (2004), it is important to allow a non-linear risk-return relationship while evaluating hedge funds. This means that non-linear option-like payoffs should not be restricted only to risk arbitrageurs and trend followers but should also be featured in a variety of hedge fund strategies. Along with this non-linear exposure to the equity market index, hedge funds also display significant risk exposure to factors of value, size, and momentum. Agarwal and Naik (2004) add that traditional portfolios with mean-variance framework underestimate losses more substantially when the portfolios have low volatility. The expected tail-losses of mean-variance portfolios tend to be underestimated as tremendously as 54% when compared to M-CVaR optimized portfolios. Therefore, ignoring the tail risks of hedge funds could result in significantly greater losses during times when markets are going down. (Agarwal & Naik, 2004.)

According to Agarwal and Naik (2004), performance and returns during the last decade are not representative of the long-term performance of hedge funds. For instance, the expected losses beyond Value-at-Risk (VaR) during the period of 1927-1989 are twice the size of those experienced during the 90s. Mean returns during the period of 1927-1989 are much lower, and their standard deviations are much higher compared to recent performance of hedge funds. This implies that long-run returns were lower at that time, volatilities were higher and tail losses were greater across almost all hedge fund indexes in comparison to those during the recent periods. These results give important indications for risk management and portfolio decisions, such as constructing and benchmarking a hedge fund. Therefore, hedge fund benchmarking, hedge fund tail risk, stability and manager compensation should raise crucial concerns among investors. (Agarwal & Naik, 2004.)

2.1.2 Credit risk

Brown et al. (2013) show that hedge funds and financial intermediaries are directly connected to each other through credit risk exposures. These exposures originate from prime brokerage activities, trading counterparty exposures in OTC markets and

financing of short-run leveraged positions. Using high levels of leverage is one of the main features of hedge funds, therefore evaluating credit risk as a risk-component is vital. Credit risk emerges from the possible outcome that borrowers and their counterparties may default. It is therefore considered to be one of the most important risks among financial institutions, and most of financial institutions dedicate remarkable resources to managing and measuring it. (Hull, 2018. p. 542).

Bodie et al. (2014, p. 468) add that credit risk, which can also be defined as Bond default risk, is often measured by Standard & Poor´s Corporation, Moody´s Investor Services and Fitch Investors Services. These corporations provide financial data combined with quality ratings of vast corporate bond issues. The quality ratings of each firm's bonds reflect its risks of resulting defaults. For instance, bonds rated BBB or above by S&P or Fitch are viewed as investment-grade bonds, implying a small possibility of a default. Bonds that are rated beneath these grades are defined as junk bonds or speculative-investment grade bonds, which implies a higher possibility of defaults.

The financial crisis of 2007-2009 is often described as a credit crisis when due to increasing amounts of defaults, the lending among financial institutions stopped functioning. Many defaults resulted from the sequence of other defaults which means that many lenders were exposed to defaults from institutions they were not directly trading with. Such situations also create additional systematic risk in the markets. (Bodie et al., 2014, p. 477.)

There are certain ways for banks and other financial institutions to mitigate their exposures to credit risk. One of which is by using credit derivatives. Credit derivatives can be used to transfer the credit risk from one company to another and for diversifying credit risk, by swapping one type of risk exposure with another. The most common form of credit derivative is a credit default swap or CDS. Credit default swap is a certain type of contract or agreement in which a company buys an insurance from another company to counter the possibility of third companies defaulting. (Hull, 2018, p. 591.)

Moreover, Chambers et al. (2018, p. 96) assert that a hedge fund manager that wishes to transfer its exposure to a certain risk - regarding for instance corporate debts- can use CDSs to make these shifts effectively and promptly. For instance, fixed-income arbitrage hedge fund managers can take offsetting positions as buyers and sellers via CDS agreements by applying their skills to analyze credit risk. Therefore, credit default swaps are a great way to create synthetic exposures to corporate bonds that provide increased liquidity of hedge fund portfolios, mitigated transaction costs, and superior capability to reduce exposures to credit risk. (Chambers et al., 2018, p. 96.)

2.2 Illiquidity related risks

In theory, liquidity is the ability for an investor to gain or liquidate one´s assets. For instance, when investing in equity markets, one has an almost instant access to funds if needed. Buying stocks or bonds can be described as traditional investing methods. Alternative investments such as hedge funds, private equity, real assets, and structured products provide different types of liquidity compared to traditional investments. Access to and liquidation of alternative assets can be restricted. Investing in hedge funds places asset allocators under a certain risk of illiquidity, since many private hedge fund products are potentially illiquid. The infrequency of trades inside hedge funds lowers their liquidity, and an increasing amount of hedge funds only post a net asset value, or NAV at the end of the month, which means that money can only be withdrawn or added to the fund at the end of each calendar month. In addition to this, many hedge funds have specific calendar requirements for withdrawals from or additions to the fund, and funds may include a mandatory notice before redemptions. Some hedge funds only have monthly subscriptions and quarterly redemptions with a notice of 30 days, which gives the hedge fund manager time to liquidate the fund's positions for the investor's redemptions, but also adds illiquidity to an investment. (Chambers et al., 2018, pp. 22–23.)

Joenväärä and Tolonen (2008) state that it is typical for hedge funds to enforce redemption and lockup periods. Mutual funds often provide a daily liquidation of assets for their clients, meaning that liquidation is managed daily while hedge funds are less regularly entirely open-end funds. According to Bodie et al. (2014, p. 96), lock-up periods in hedge funds allow hedge fund managers to invest in more illiquid

assets, since the redemption of assets is restricted by lock-up periods. Thus, due to light regulation, hedge funds are able to resort to investment strategies such as short sales, usage of derivates and use of leverage, all of which are not achievable in mutual funds. Agarwal, Ruenzi and Weigert (2017) add that since the funds including longer lockup periods are more likely to invest in illiquid securities, they are also more prone to tail risk.

When discussing particular hedge fund strategies, Khandani and Lo (2007) point out that the serious increase in strategies for illiquidity of long/short equity over the past decade can be explained by the proliferation of equity funds and capital per fund, with the addition in the amount of leverage used within each fund. However, some hedge fund styles, exclusively those categorized as relative-value and event-driven strategies, may include highly concentrated, levered, or illiquid underlying investments, which can require investors to sustain longer holding periods. Hedge fund strategies which hold distressed debt, unlisted equity securities, illiquid fixed-income securities, or other illiquid and levered positions may include lockup periods for the investor that can require keeping their assets inside the fund from one to three years. (Khandani & Lo, 2007). Lockup periods are described as hard or soft. In soft lockup periods, investors may redeem investments early by paying a commission of 1% to 3% of the amount they are redeeming. In hard lockup periods, investors are not able to redeem their investments at all during the lockup period. (Chambers et al., 2018, pp. 23–24.)

Joenväärä and Tolonen (2008) suggest that the flexibility provided by a restriction of shares allows hedge fund managers that have lockup fees to take a surplus risk. Hedge funds with a lockup provision tend to convey lower Sharpe ratios than comparable funds without lockup conditions. Joenväärä and Tolonen (2008) further state that funds are prone to impose lockup periods when they have intentions to invest in higher risk-containing assets, while longer-notice periods for asset are used when managing illiquid investments.

In addition to lockup periods, some hedge funds may include gates that can delay redemption or withdrawal requests even beyond the lockup period in order to protect the investor's capital during times when markets are facing extraordinary and illiquid situations. One good example is the financial crisis of 2007-2009. Many debt issuers

were trading with gigantic credit spreads and excessively low prices. Rather than allowing hedge fund investors to withdraw their positions, which would force hedge fund managers to sell these positions at very distressed prices, many credit-weighted hedge-funds established gates to postpone the redemption petitions of their investors. This created a situation in which redemption requests that were submitted in the beginning of 2009 were not actually fulfilled until the year 2010, when credit market habituates had already balanced, and prices had recovered to the point where the impact of redemptions was limited. (Chambers et al., 2018, pp. 23–24.)

Illiquidity should not only be considered as an inconvenience defined as the inefficiency to sell existing investments at sensibly attractive prices without needing to take additional exposure as it also adds substantially risk in a portfolio. For instance, if we take into consideration the previous financial crisis in 2007-2009, many hedge funds and other alternative investments suffered major substantial losses in terms of liquidation, because the liquidation values were extraordinarily low. Concerning alternative assets, the unavailability of market prices exposes investors to increased costs for data gathering, monitoring, exiting and financial analysis. (Chambers et al., pp. 90-92.)

Bodie et al. (2014, p. 312) point out that in order to offset the risks and inconveniences suffered through illiquidity, additional benefits must be gained by the investors through increased compensation, so as to keep them motivated in investing into assets that are considered more illiquid. Illiquidity premium is often set to the same level as the market risk premium (Bodie et al., p. 441). According to Chambers et al. (2018, p. 148), there are two primary components to the benefits accumulated from investment: 1.) the time value of money and 2.) the compensation for bearing risk necessary for the investment. Illiquidity increases the need to bear risks and therefore, the benefit as expected return should also increase. Liang and Park (2010) mentions that even though liquidation is usually considered an issue in the context of hedge funds, liquidation does not automatically mean failure.

2.2.1 Liquidity and Lehman bankruptcy

Hull (2018, p. 4) claims that when Lehman Brothers filed for bankruptcy on September 15th 2008, it was mainly due to a combination of extremely risky investments, high levels of leverage and problems with liquidity. In this instance, Lehman Brothers had increased their leverage ratio to 31:1 by 2007, which meant that in the event their asset value declined by 3-4%, it would destroy its capital entirely. Chambers et al. (2018, p. 131) point out that during the financial crisis of 2008-2009, many investors struggled with unanticipated and problematic restrictions when trying to redeem their investments. For that reason, all investors should carefully evaluate potential redemption restrictions when allocating resources towards hedge funds. Agarwal et al. (2017) argue that during the financial crisis of 2008, hedge funds using Lehman Brothers as their prime broker witnessed higher levels of tail risk compared to other funds, which leads to the conclusion that funding liquidity shocks enhances tail risk.

2.3 Illiquidity shocks and contagion of hedge funds

Boyson, Stahel and Stulz (2010) discuss the effects of shocks to hedge fund liquidity between 1990-2008 and the fact that these liquidity shocks might be one of the main reasons for an increased probability of contagion in hedge funds. According to Boyson et al. (2010), large shocks to credit spreads, bank stock prices, stock market liquidity and hedge fund flows are correlated with a significant increase in the probability of hedge fund contagion. In this context, contagion means the event in which one bad outcome also affects or generates another. Between 1990 and 2008, the worst hedge fund returns cluster across different hedge-fund styles, and by using both parametric and semi-parametric analyses, Boyson et al. (2010) show that clustering or contagion cannot be explained by the risk factors commonly used to explain hedge fund performance.

According to Brunnermeier and Pedersen (2009), an adverse shock to the funding liquidity of hedge funds forces them to reduce their leverage and contributes less liquidity to the markets, which then reduces asset liquidity. Adrian et al. (2011) describe these situations as liquidity spirals, in which initial losses in some asset classes may force investors that leverage their holdings with great magnitude to reduce

their positions, which in turn leads to additional losses and potential spillover of these losses to other asset classes. If the impact of the funding liquidity shock on the asset liquidity is heavy enough, the decrease in asset liquidity makes funding even more inflexible for speculators, which causes a self-reinforcing liquidity spiral. In such a spiral, both the funding liquidity and the asset liquidity continue to crumble. (Boyson et al., 2010). Adrian et al. (2011) note that issues related to liquidity spirals spread distress of financial crisis across many institutions and therefore, in regard to financial stability, understanding to which degree various hedge fund strategies simultaneously experience vast losses is important.

The financial crisis of 2008 could be described as a credit crisis which emphasized the role of liquidity spirals: the impact of the subprime crisis regarding Collateralized Debt Obligations (CDO), Credit Default Swaps (CDS) and Mortgage-Backed Securities (MBS) on margins led to a sharp reduction in liquidity in most asset markets during the second half of 2008. In relation to this, the clustering of hedge fund returns was also really dramatic. (Adrian et al., 2011.)

According to Brunnermeier and Pederson (2009), shocks to asset liquidity and to the funding liquidity of hedge funds lead to poor performance of assets and hence, lead to hedge fund contagion. While Brunnermeier´s and Pedersen´s (2009) research focuses more on the severe effects of financial crises, the research made by Boyson et al. (2010) studies the coincidence of poor performance in hedge funds since 1990 by including eight different hedge fund styles: convertible arbitrage, distressed securities, event driven, equity hedge, global macro, equity market neutral, merger arbitrage and relative value arbitrage. They demonstrate that large negative shocks to asset liquidity and to the funding liquidity of hedge funds make hedge fund contagion more probable.

Boyson et al. (2010) show that there is very strong evidence and association of contagion in hedge fund returns. As a result, from a lower level of leverage, asset liquidity inside hedge-funds worsens, which then leads to even further deleveraging. In turn, a similar shock to funding liquidity leads to deleveraging, which then reduces asset liquidity within hedge funds as well. It is shown that small shifts in liquidity are not associated with hedge fund contagion. The shifts in liquidity need to be vast and radical for the liquidity to be associated with hedge fund contagion. Hedge funds seem

to share a common exposure to large liquidity shocks such as previous financial crises, and the current models explaining hedge fund returns do not sufficiently apprehend this exposure. (Boyson et al., 2010.)

2.4 Option like nature of manager-incentive fees

In order for hedge funds to succeed, they need their managers to be flexible, successful and especially skilled. Chambers et al. (2018, p. 24) show that the competence of hedge fund managers is financially compensated with management fees. Management fees are often calculated as a percentage of the assets under management and incentive fees as a percentage of the fund´s profit (Adrian et al., 2011). Often, the annual management fee ranges between 1% - 2% of the assets, and it is a fee paid regardless of hedge fund's performance. Incentive fee is based on the performance of the hedge fund, usually paid annually, and it accounts for between 10%-20% of all new profits generated by the fund. Due to the previous financial crisis of 2008, management fees for large institutional allocations have dropped to between 1,5% and 15%. (Chambers et al., 2018, p. 24.)

Chambers et al. (2018, pp. 24–26) point out that incentive fees have an embedded tendency for a moral hazard. While traditional mutual funds only charge a flat management fee that is not affected by the success of the fund, hedge funds include managerial incentive fees that increase with the returns generated by the fund. In this case, moral hazard lies between the investors and hedge fund managers. Investors are concerned that the previously mentioned incentive fees may increase unnecessary risk-taking by hedge fund managers. If a general partner (the manager of the hedge fund) earns an incentive fee of 20 % profit and all the while does not share the possible drawbacks of losses, they can be prone to invest in highly volatile strategies. In this particular situation, managers profit even more when the risk-taking is fruitful and they do not carry the burden of possible losses. The incentive fees described in this situation can be explained as a call option that is held by a hedge fund manager against the performance of the fund. Similarly, like having a call option on the fund´s assets, an option-like feature could provide a large positive return when the fund´s assets are gaining in value and could exclude an exposure to losses in the event that the value of the fund´s assets declines. (Chambers et al., 2018, pp. 24–26.)

Jiang and Kelly (2012) show that when hedge fund managers do not invest their own wealth in funds they are managing, standard principal-agent problems arise. In these situations, the manager is willing to take additional risks in order to gain more incentive fees and capture more inflows towards the fund. Adrian et al. (2011) show that while reducing risks could be advantageous to the fund manager in that it would lower the hedge fund's exposure to tail risk, managers still have strong incentives to take additional risks, as they tend to expand possibilities for additional incentive and management fees. Agarwal et al. (2017) add that call option characteristics of a managerial incentive fee are positively associated with hedge fund tail risk. Features of the incentive fees such as the call option encourage managers to take additional tail risk-tilted investments.

Agarwal, Daniel and Naik (2009) show that funds with higher managerial incentives and ownership, strict withdrawals, and other managerial restrictions report better returns compared to risk-adjusted funds. These findings strongly suggest that hedge fund contracts are indeed compelling in motivating managerial efforts and mitigating agency problems within hedge funds. According to Chambers et al. (2018, pp. 26–27), the moral hazard of incentive fees and the very high levels of risk-taking by hedge fund managers can be offset to some extent by including the managers' own personal wealth into the fund. This method includes both variations: the incentive to make good results and earn incentive fees, but also the negative aspect of the general partners losing something along with the limited partners, which refrains managers from having an audacious investment behavior. The possible downside with a large personal capital involvement of hedge fund managers in funds is that if their own financial security is endangered, they might not take sufficient risk in order to obtain the optimal results that primarily characterize hedge funds.

2.5 Tail Risk

Why is it important for an investor to evaluate tail-risk and other risks related to hedge funds? Usually, tail-risks are considered as extremely negative and unwanted factors in respect to profits, since tail losses can be colossal for hedge funds. Jiang and Kelly (2012) argue that hedge funds witness constant exposures to tail-risks and other extreme downside risks. Tail-risk is often correlated with illiquidity, and the

possibility for tail risk- related problems is even more present in situations in which the hedge fund is highly leveraged. In the occurrence of disastrous events, the capital of highly leveraged hedge funds might be obliterated, as the fund struggles to liquidate its funds and allow the withdrawal for its investors. (Jiang & Kelly, 2012.)

Chambers et al. (2018, p. 121) argue that since many alternative investment variations, such as hedge funds, offer a possibility for both elevated returns and increased tail-risk, it is vital for investors to bear some level of tail-risk in order to capture well-diversified portfolios with great returns. Tail-risk measures the possibility and harshness of the risk of extreme outcomes. Often, tail-risk originates from the tail left in the distribution of returns (Bodie et al., 2014, p. 148). Most investment strategies usually expose the investor to some level of tail-risk, and it is not a question of whether an investment strategy has a tail risk but is rather about to which extent the tail is severe, and whether it is properly managed and understood. Generally, alternative investments tend to contain more tail-risk than traditional investments. (Chambers et al., 2018, p. 114.)

Agarwal et al. (2017) show that the main determinants for tail-risk are discretion, and an exposure to funding liquidity shocks and managerial incentives. Agarwal et al. (2017) also argue that the sources of tail-risk mostly originate from the tendency of hedge funds to put writing strategies via equity markets as well as from equity-based tail risk factors such as investments in stocks with high tail-risk. On the contrary, funds taking longer positions in equity-put options tend to witness lower consequences of tail risk.

Chambers et al. (2018, pp. 115–121) point out that tail-risk generally originates from the following issues: changes over time in an investment strategy called the investment strategy drift, a strategy drift towards higher risk or leverage, rogue traders, operational failures, and issues regarding fraudulent actions. In order to mitigate the effects of tail-risks, investors are obligated to perform due diligence on their investments, monitor the funds, follow the money, and pay some attention to the fund culture into which the investor is willing or trying to invest their assets.

According to Adrian et al. (2011), hedge funds are more susceptible to tail-risk related issues during times of crisis. Adrian et al. (2011) add that it is vital for overall risk management and other financial stability aspirations to understand the degree to which different hedge fund strategies are prone to tail risks and tail-risk related problems which arise markets are in turmoil. Patton (2009) proposes the possibility that some hedge fund strategies categorized as market neutral may have secured themselves from tail risk. Market neutral hedge funds are sometimes described as market-tail neutral. In addition, Jiang and Kelly (2012) show that some hedge fund strategies are more exposed than others to poor results related to tail-risk. In particular, strategies that invest in emerging markets and long-short equity hedge fund strategies especially exposed. More precisely, one standard deviation shock to tail-risk is followed by a 4,44% annual drop in long-short equity strategy and a whopping 7,20% drop in the hedge fund strategy of emerging markets. Adrian et al. (2011) argue that tail sensitiveness among different hedge-fund strategies is greater during times of financial distress in the markets, which suggests that potential simultaneous losses among hedge funds during financial distress do exist.

On the other hand, Jiang and Kelly (2012) point out that tail risks have a vast impact on asset prices, even though crashes of hedge fund markets are rather infrequent. Hedge funds can be thought of as strategies that provide insurance against possible market crashes. In consequence, they earn attractive premiums during tranquil market conditions and suffer severe losses in bad market conditions or within tail events. Therefore, the question arises about whether or not the returns enjoyed by hedge funds during tranquility times compensate the tail-riskiness of hedge fund investments. Bali et al. (2007) find that hedge funds which endure higher left-tail risk outperform the funds with less tail-risk exposure. Gao, Gao and Song (2018) present a differing view on hedge fund related risks and market disasters. According to Gao et al. (2018), hedge funds are actually able to benefit from disastrous market conditions rather than being exposed to market disasters and tail risks.

2.5.1 Value-at-Risk, Expected Shortfall and hedge fund performance

Value-at-Risk or VaR could be defined as a measure of the worst possible loss that can occur over a certain period of time. (Gupta & Liang, 2005). Chambers et al. (2018, p.

141) explain that Value-at-Risk or VaR is an approach for estimating risks that are based on quantiles. For example, a 5% VaR implies the level of possible losses that are anticipated to be met or exceeded in 5% of the possible outcomes during some period. Figure 2 demonstrates VaR in the case of a symmetrical distribution.

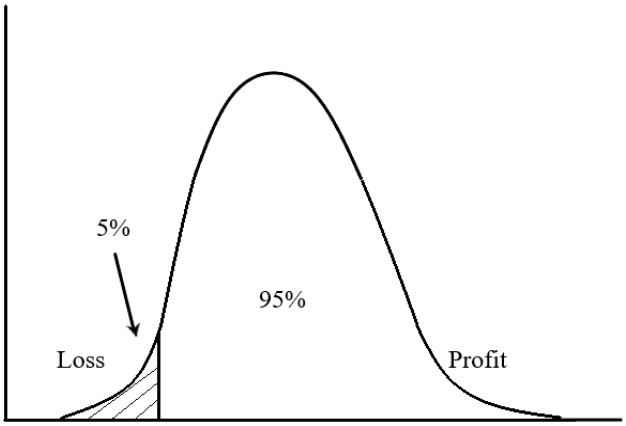

Figure 2. Value-at-Risk illustrated for symmetrical distribution (according to Chambers, Black, & Lacey, 2018, p. 142)

Analysts use VaR for two main reasons. The first one is that VaR is an easily understandable measure of risk exposure in a certain portfolio or a position, because it gives the best estimate of the possibilities for numerous losses. The second major reason for using VaR is that it is helpful in outlining possible risks when the outcomes are not structured as a normal probability distribution. (Chambers et al., 2018, p. 141.)

Gupta and Liang (2005) compare traditional risk measures and VaR to evaluate hedge fund risk and find that for this purpose, standard deviation is not as performant as VaR, due to the substantial kurtosis and negative skewness present in hedge fund returns. Using standard deviation and assuming a normality of hedge fund returns can result in underestimating the real risk of the hedge fund industry. Liang and Park (2010) also show that measures such as Expected Shortfall are superior to standard deviation-related measurements when estimating the downside risks or the failure of a hedge fund. Related literature from Agarwal and Naik (2004) and Liang and Park (2007) argues as well that measurements related to standard deviation greatly underestimate left-tail risks within hedge funds.

Bali et al. (2007) test VaR by using two large hedge fund databases from Lipper TASS and Hedge Fund Research – or HFR, using monthly returns of hedge funds during the period from 1995 and 2003. Their findings suggest that investors holding portfolios with higher levels of VaR can also expect superior returns, implying the existence of a risk premium relationship between the downside risk and the expected returns of hedge funds.

As explained previously, tail risk is one of the greatest concerns regarding hedge funds. Bodie at al. (2014, p. 162) state that value at risk (VaR) and expected shortfall (ES) are used to measure tail risk. VaR measures the exceeding probability of incurring loss. For instance, when negative deviations from the normal distribution are larger and more frequent, a VaR of 5% may represent a 1.65 standard deviation below the average return. Meanwhile, the ES measures the possibility that the expected rate of return falls below a certain value. For instance, an ES of 1% is the expected return of all possible outcomes within the 1% of the normal distribution.

Bodie et al (2014, p. 141) claim that VaR works well for estimating risks, as it totally ignores potential gains and digs into the downside risks of investments. For instance, VaR could indicate to an investor that they have a 10% possibility of losing more than 5% in a single day. According to Bodie et al. (2014, p. 141), the problem with VaR is that it does not work well when estimating the possibilities of worst downside scenarios. For measuring extreme risk, many firms have begun using conditional value at risk (CVaR) or expected shortfall (ES), which show the possible losses after going past value at risk. CVaR makes it easier for companies to estimate the significance of expected losses when they are especially severe. Agarwal and Naik (2004) examine portfolio decisions in the light of nonlinear option-like payoffs of hedge funds and in order to do so, they use a conditional value-at-risk (CVaR) framework, which is especially useful for examining negative tail risk. VaR focuses more on the frequency of severe events while CVaR focuses on the frequency and size of losses in the cases of severe events.

2.6 Measuring performance of Hedge Funds

There are two main components when estimating anticipated compensations from an investment. The first is the time-value of money and the second is the investment-related compensation for enduring such investment-related necessary risks. Compensation for the time value of money is usually estimated with the risk-free interest rate of short-term government securities. Compensations for an investment-related necessary risk are typically estimated with the risk premium of bearing systematic risk for different kinds of investment objects. (Chambers et al., p. 149.)

Chambers et al. (2018, p. 143) propose that the Sharpe ratio is one of the most popular and simple measures of risk-adjusted performance used in traditional investing. The famous Sharpe ratio measures the expected return of an asset compared to a unit of volatility. Volatility is often measured with a standard deviation of returns.

$$\frac{E(R) - Rf}{\sigma} \tag{1}$$

Where $E(R)$ stands for expected return, Rf stands for riskless return or rate of interest and σ represents the volatility of the return of asset. According to Chambers et al. (2018, p. 143), the Sharpe ratio at its simplest could be defined as the measure of rewards for tolerating total risk, but the possible drawback comes from the fact that using volatility as a measure of risk will ignore the potential advantages of diversification. Other problems with the Sharpe ratio occur when assets do not include symmetrical distributions. Hence, a ratio called the Sortino Ratio could be used. (Chambers et al., 2018, p. 143.)

The reason why focusing solely on Sharpe ratios in the case of hedge funds is not considered efficient comes from the nature of many hedge fund strategies, as these funds tend to focus less on broad diversification of assets and more on the opportunities that arise from momentarily mispriced securities. (Bodie et al., 2014, p. 880.)

According to Chambers et al. (2018, pp. 143-144), the Sortino ratio modifies the Sharpe ratio by replacing volatility with the measure of asset´s downside risk. The

downside risk is not something that is strictly defined but has a rather general way of using it. The Sortino ratio provides a great way for measuring the risk premium that is available per unit of downside risk.

$$\frac{E(R) - Rf}{Downside\ risk} \tag{2}$$

When evaluating managers in the context of Hedge Funds, capture ratios are often utilized as well. Capture ratios measure the capability of hedge fund managers to time their positions with market conditions. For example, taking on additional exposures in systematic risk during bullish markets and taking positions with mitigated risk exposures during bear markets. Capture ratios greater than 1.0 during bullish markets indicate a profound success while measures under 1.0 suggest failure. In opposition, downside capture ratios under 1.0 indicate a prosperous market timing. For example, a downside capture ratio of 0.8 would suggest that the manager only lost 80% of what the index lost. (Chambers et al., 2018, p. 145.)

2.6.1 Alpha and other important Hedge fund related factors

Chambers et al. (2018, p. 147) explain that alpha is a great measure for assessing hedge fund related performance and that beta measures systematic risk. Alpha primarily has two distinct functions. Firstly, alpha indicates the amount of excess anticipated returns. For example, if a hedge fund delivers a 3% alpha annually, it means that it constantly outperforms the priced assets with a similar 3% risk per year. The second function of alpha is to measure the difference between the return of an asset and its comparable benchmark, after adjusting risk variances between the benchmark and the asset. For example, in this context a 5% alpha per annum would indicate that the hedge fund outperformed a properly assembled benchmark by 5% that year.

According to Chambers et al. (2018, p. 156), one of the main reasons for investing in alternative assets such as hedge funds is to try and gain absolute returns, or returns that are not highly correlated either with macroeconomic variables or with significant asset classes. Good examples of hedge fund strategies pursuing absolute returns are market-neutral hedge funds and funds specializing in some sort of arbitrage, since these funds

go after investment strategies that prioritize returns that are not correlated with the returns of traditional assets. One feature of these funds is that even though they bear similar risks to all hedge funds, the risk is labelled as nonsystematic. In theory, absolute return funds offer the advantage of earning superior returns without exposing the fund to additional interest-rate risk, credit risk or equity market risk. (Chambers et al., 2018, p. 150.)

One particularly common index model, the Capital Asset Pricing Model (CAPM) introduced by Sharpe (1964) and Lintner (1965), is frequently defined as the basic starting point when assessing the theoretical context of market-neutral investments and when assessing the relationship between returns provided by the market and by investment vehicles such as hedge funds. According to Muhtaseb and Colborn (2012), the slope of regression in the CAPM model, beta, measures the correlation and sensitiveness of securities against the market risk. Sharpe (1964) and Litner (1965) determine beta in the following manner:

$$\beta_f = \frac{cov(R_{f,}\ R_m)}{\sigma^2\ (R_m)}. \tag{3}$$

Hedge funds´ beta (β_f) from equation three is obtained by dividing covariance of hedge fund and market returns $cov(R_{f,}\ R_m)$ by the variance of the market return $\sigma^2\ (R_m)$. Patton (2009) describes the correlation and beta-based analysis of hedge funds neutrality against market returns as one of the most commonly used and straightforward methods. Patton (2009) claims that hedge fund investors aim to bring beta as close to zero as possible in order to gain holdings that are neutral from overall market movements. Muhtaseb and Colborn (2012) add that many hedge funds have the same target, since it then indicates that these funds provide returns that are not sensitive to market returns. Patton (2009) states that simple linear regression models such as CAPM and beta -values do not provide optimal value for assessing return characteristics generated by hedge funds, due to their employment of dynamic and complex trading strategies, as well as to the fact that hedge-fund payoffs are often rather nonlinear.

Regardless of these contributing factors presented by Patton (2009), Asness, Krail and Liew (2001) argue that potential investors of hedge funds simply do not have any other options than to rely on linear regression models such as CAPM, previous return characteristics and superficial descriptions of hedge fund strategies, since the information provided by hedge funds is often highly limited.

Asness et al. (2001) show that since hedge funds generally provide only limited information about their holdings and returns characteristics, investors that are interested investing in hedge funds must establish their evaluation based on the history of returns of these hedge funds and the descriptions of their strategy. Therefore, Asness et al. (2001) introduce a common approach for estimating the market exposure of hedge-fund returns in a regression that includes the hedge fund's monthly returns against S&P 500 index returns, in this case representing the overall market returns:

$$R_{i,t} = a_i + \beta_i R_{m,t} + \varepsilon_{i,t} \ . \tag{4}$$

This equation is rewritten as follows:

$$R_{i,t} - \beta_i R_{m,t} = a_i + \varepsilon_{i,t} \ . \tag{5}$$

Where $R_{i,t}$ represents the return on hedge fund i net-of-fees, $R_{m,t}$ represents the return on the S&P 500 index excess of cash, also excluded of fees. The left side in equation 5 represents the return of a hedge fund strategy, where β_i division of units of the S&P 500 are shorted against the purchase of a hedge fund. On the right side of equation 5, a_i represents the added value, or alpha since it is the average return for the hedge fund and can also be viewed as the accomplished skill of the manager. Asness et al. (2001) add that this regression represents an estimate of alpha, because it accounts for the added value that the hedge fund produces after taking into consideration the average market exposure, or in other words, beta. Element $\varepsilon_{i,t}$ represents the variables that differ from market return, and according to Asness et al. (2001), it is estimated to have zero mean, or no value, in this regression. This regression describes the relationship between market and hedge fund as being linear, which according to Patton (2009) is

not acceptable, since hedge funds tend to employ many different strategies for dynamic trading, and since payoff functions are often nonlinear.

In addition to these measures, R-squared (R^2) is a commonly used statistical tool for analyzing a possible neutrality between hedge funds and market returns. R-squared measures the level to which the descriptive variable (for instance market return) explains the dependent variable (in this case, the returns of hedge fund strategies). Adjusted R-squared is used in order to mitigate the possible errors created by normal R-squared measures, as the latter tend to rise when more explanatory variables are introduced into the regression models. According to Titman and Tiu (2011), a low R^2 (closer to zero than to one) could be an indicator of managerial success and skill, combined with possible signs of market neutrality. Fung and Hsieh (2004) prove that using R^2 to estimate hedge fund returns is useful. The problem with R^2 in regression models with multiple factors, such as in the 7-factor model presented by Fung And Hsieh (2004), is that the value of R^2 increases when more factors are included. Therefore, adjusted R-squared measures may have a more explanatory influence, as they are more neutral when additional factors are added to the model. (Fung & Hsieh, 2004).

3 FINANCIAL CRISES AND HEDGE FUNDS

Adrian, Brunnermeier and Nquyen (2011) claim that the recent global crises of 2007-2008 presented many illustrations of broad hedge-fund failures. The financial crisis began in June 2007 when two highly levered structured-credit hedge-funds failed. Later, in March 2008, another highly levered fixed-income fund, Carlyle Capital Corporation (CCC) fell into bankruptcy due to margin calls. Chambers et al. (2018, p. 114) explain that the collapse of CCC was caused by monumental leverage and risk-measurement errors made by rating agencies, as they incorrectly assigned superior credit-ratings to various structured products. When Lehman Brothers failed in September 2008, the whole hedge fund sector experienced harsh losses.

Jiang and Kelly (2012) show that when investigating hedge fund performance, two extreme crises should be taken in consideration: the financial crisis of 2007 – 2008 and the crisis of 1998. The earlier major crisis in 1998 is often described as the credit crisis. It originated with the Russian debt default which led to the collapse of a major hedge fund, the Long-Term Capital Management, or LTCM, and eventually affected the entire hedge-fund-industry returns negatively. Chambers et al. (2018, p. 115) clarify that LTCM´s main investment strategy focused on fixed-income arbitrage, which included identifying assets that are relatively mispriced. One of the main reasons why LTCM collapsed was the massive use of leverage combined with the liquidity crisis when liquidation was fulfilled with losses.

On the other hand, the more recent financial crisis derived from crowded high-risk trades and, according to Hellwig (2009), from exposure to highly risky and faulty subprime mortgage markets. These market conditions caused unpredictable, vast, and rapid losses also among hedge funds. That said, Agarwal et al. (2017) argue that during the recent financial crisis of 2008, the tail risk among hedge funds was unquestionably lower than the tail risk computed among hypothetical buy-and-hold equity portfolios. In addition to this, they find that prior to the crisis of 2008, hedge funds increased their long positions in put-options. These findings suggest that during the financial crisis of 2008, hedge funds actually on average reduced the exposure to tail risk they held prior to the crisis, which indicates to some extent an ability for hedge funds to time tail-risks.

Jiang and Kelly (2012) show that many hedge funds which performed poorly during the first major crisis in 1998 had an inclination towards bad outcomes in the crisis of 2007-2008 as well. More precisely, a 1% drop in the performance of a hedge fund in 1998 also predicted a 0,56% drop in the crisis of 2007 -2008, implying that the funds performing worst in the first crisis also ended up performing poorly in the latter one. The predictability of poor performance is a sign of the high propensity in hedge funds towards exposures to extreme downside risks and tail risk.

According to Billio et al. (2010), financial crises have certain effects on hedge funds. Financial crises have a major impact on hedge fund risk, and the common risk factors during crises are liquidity, volatility, and credit or equity markets. In addition to these risk factors, idiosyncratic risk factors also need to be taken in consideration, as without them, the effects of financial crises on hedge fund risk are grossly undervalued. These risks apply to many of the strategies previously mentioned in this master´s thesis. In this particular case, the idiosyncratic risk factors are called latent risks, and were very common across the hedge fund industry during the 2008 international financial crisis, as well as during the LTCM (Long-Term Capital Management) crisis of 1998. This common latent factor is also associated with well-known negative hedge fund success measures such as margin spirals, colossal redemptions, credit freezes, runs on hedge funds and market-wide panic.

It is interesting and important to analyze hedge funds during crises, since one of the main attractions of hedge funds is their characteristic of low vulnerability to market risk. The financial crisis of 2008 showed the markets that hedge funds might not include as little a market risk as it is perceived, and many investors even questioned if these hedge funds were actually hedged. According to Billio et al. (2010), all hedge fund strategies performed dreadfully during the crisis of 2008. Also, as one of the main purposes of investing in hedge funds is their advanced level of diversification, according to Billio et al. (2010), the correlation of hedge fund strategies increased from 0.32 (8/2008) to 0.52 (9/2008), which is a 64% increase. The results implicate a severe correlation between hedge fund strategies. Moreover, Billio et al. (2010) show that the average correlation of hedge fund strategies between January 1994 and December 2008 increased with great magnitude during financial crisis periods. In particular, the average correlation between different hedge fund strategies rose by 50% (0.12 to 0.31)

in August 1998, and by 64% (0.32 to 0.52) during the more recent financial crisis of 2008, which is quite extreme. The volatility of hedge fund strategies can vastly vary as well, but in any case, it greatly increases during financial crisis periods. The smallest changes of volatility in hedge fund strategies were in the Equity Market Neutral hedge strategies (38%), and the most considerable increase in volatility was in the Convertible Bond Arbitrage hedge fund strategy (176%). (Billio et al., 2010.)

According to Khandani and Lo (2007), hedge funds that mainly invested in exchange-traded equities and usually performed outstandingly, suddenly experienced considerable and unprecedented losses during the financial crisis of 2008. In particular, the hedge funds that suffered the hardest downfalls were the ones implementing investments in long/short equity market-neutral strategies, those very ones which do not generally have compelling beta exposure and are supposed to be immune to market fluctuations. During financial crises, the median volatility and the correlation of hedge fund strategies increase. Liquidity, volatility, and credit risks are the most common systematic factors affecting the risks in hedge funds. Moreover, funds that have an exposure or correlation to the S&P 500 index during crisis periods are comparably smaller compared to periods of tranquility. This implies that managers of hedge funds attempt to lessen their market exposures during times of crises and high volatility. In the case that common latent-risk factors and hedge fund risk exposure are left out when modelling risk, the effects of financial crises on hedge fund risks and their magnitude are highly underestimated and the benefits of hedge-fund diversification are vastly overestimated. In order to fully apprehend the effects of financial crises, both the latent and the systematic risk factor liabilities should be modeled within hedge fund risk. (Billio et al., 2010.)

It is therefore legitimate to question whether hedge funds are really hedged since their correlation climbs so rapidly during times of financial crises. The presence of exposures in classical systematic-risk factors may lead to gains in correlation and volatility during financial crises. On the other hand, the exposure of common latent-risk factor liabilities restrains possible benefits of diversification, increases volatility and correlation, and makes discovering of arbitrage positions or price inefficiencies harder for hedge fund managers. (Billio et al., 2010.)

3.1 COVID-19 and Hedge Funds

Ding et al. (2020) argue that the economic crisis caused by COVID-19 was nothing like previous crises such as the one in 2008, when financial imbalances grew out of control. The COVID-19 crisis was mainly caused by a global pandemic that laid vast economic constraints on all economical activities. In order to give some perspective, the S&P 500 fell approximately 34% within the first quarter of 2020. Ding et al. (2020) use data from 6,000 different companies during the first quarter of 2020 in order to evaluate stock price movements and corporate features to COVID-19 events. Ding et al. (2020) disclose that stock prices of firms that had high levels of hedge fund ownership performed much worse than companies with less exposure to hedge funds. The reason why the stock prices of many companies move more rapidly when having big ownerships in hedge funds is due to two main reasons. Firstly, hedge funds commonly utilize quantitative trading strategies that can lead to overcrowding in holdings and secondly, hedge funds tend to use short-term financing to leverage their holdings. In the event of unfavorable news regarding COVID-19 cases or similar adverse shocks, these two main characteristics might cause stock prices to further drop among companies that have great ownerships within hedge funds. Again, when necessities for liquidity increase among hedge funds, they tend to sell their assets quickly as new unfavorable information about COVID-19 cases emerges to the markets, which creates downward pressure on the stock prices as well. (Ding et al., 2020.)

According to He, Nagel and Song (2020), U.S Treasuries are usually perceived as one of the safest and most liquid assets available in the economy. Usually in a financial crisis, when prices of illiquid and risky assets drop drastically, the price premium and usage of treasuries increase. Occurrences in 2020 during the COVID-19 pandemic did not follow the normal pattern, as prices of long-term treasuries also declined abruptly. Hedge funds often use treasuries and repo- markets for pursuing their leveraged investment practices. In the context of the COVID-19 crisis, hedge funds that were employing heavy-cash future-based trading had to lower their degrees of leverage, after facing significant losses that followed the turmoil in treasury markets. (He et al., 2020.)

4 HEDGE FUND STRATEGIES

Bodie et al. (2014, p. 928) state that hedge fund strategies could be divided into two main categories: directional and non-directional strategies. The functions of directional strategies are rather easy to interpret, as they simply take chances on one sector of the markets outperforming another. On the other hand, non-directional strategies seek to take advantage of situations in which certain security valuations are misaligned. When investors are selecting potential funds to invest in, both operational and investment due diligence should be performed in addition to investment strategy returns and risks (Chambers et al., 2018, p. 28).

Fung and Hsieh (2001) point out that hedge fund strategies often include option-like returns. Chambers et al. (2018, p. 37) explain that hedge fund strategies can differ extensively. What generally differentiates hedge fund strategies are their features of including risks (lower to higher) and their defensive to more bullish aspects within the strategy. Managed-future and macro funds have a tendency to profit in times of market downfalls and crises, whereas most of equity hedge funds flourish in times of bullish and rising equity markets. Relative-value funds and event-driven funds focus on security-specific tendencies, seeking to profit from market inefficiencies. The above-mentioned funds operate best in stable and normal market surroundings, when credit spreads are also stable and equity market prices are rising due to economic growth. On the other hand, these strategies suffer in value during times of uncertainty and crisis. (Chambers et al., 2018, p. 37.)

According to Khandani and Lo (2007), there is a clear distinction between hedge fund strategies. Hedge fund strategies can mainly be categorized either in statistical arbitrage, long/short equity, or quantitative equity market-neutral strategies. Statistical arbitrage refers to deeply technical and rather short-term strategies. These strategies involve numerous securities, short holding periods and massive computational trading with a big IT infrastructure. On the other hand, quantitative strategies could rather be described as “general”, as they involve more types of models, fewer securities, and adds other alternatives to historical prices such as earnings projections, accounting variables and economic indicators. As to long/short equity strategies, they are considered as the broadest, since they can basically include any kind of equity

portfolios (short-selling, market-neutral, long-biased, and fundamental stock-pickers) and in most hedge-fund related databases, they are described as the largest category in terms of the number of funds and assets. (Khandani & Lo, 2007.)

This thesis will mainly focus on four variations of hedge fund strategies. They are categorized as follows: macro and managed-future funds, relative-value funds, event-driven hedge funds and equity hedge funds. Since these four general variations of hedge funds include many subtypes that are utterly different from each other, it is presumably enough to examine only them. Each subtype differs in terms of returns, risks, and trading practices. Many of the hedge fund strategies within this thesis include variations of arbitrage, hedging and varying short and/or long positions. Therefore, it is relevant to first define these variables.

4.1 Hedge fund strategies related variables

As the following strategies within this thesis include many mentions and implications of the concept of arbitrage, it is best to first clarify the meaning of this concept. Basically, arbitrage can be described as an investment strategy which ensures superior return without risks. In the real world, this is not viewed as something accessible, and in practice, arbitrage is defined as a strategy that attempts to exploit market inefficiencies and generate profits by doing so (Brealey, Myers, Mohanty & Allen, 2012, p. 327). Hull (2018, p. 16) also describes arbitrage as a situation that involves riskless profit by entering two or more markets at the same time.

Some of the derivatives and other hedge-fund relative trades are performed in exchange traded markets, but countless of trades take place in OTC (over the counter) markets. Usually, the counterparts trading in OTC- markets are either banks, fund managers, corporations, and other extensive financial institutions. What makes OTC-derivative markets stressful is their lack of regulation, and this is one of the main causes of the credit crisis that started in 2007 (Hull, 2018, p. 3). In order to give some insight about the magnitude and size of OTC- markets in comparison to ordinary exchange-traded markets, in December 2015, the size of the over-the-counter market was $492.9 trillion and during the same time, the size of exchange-traded markets was only $63.3 trillion. (Hull, 2018, p. 5.)

In order to explain long and short positions, one must first define what a forward contract is. Forward contracts are a quite simple form of derivatives. Basically, a forward contract is an agreement to buy or sell an asset for a certain price at some future time. Forward contracts are usually traded between two financial institutions in the previously mentioned over-the-counter markets. The usual situation in a forward contract is for one party of the contract to have a long position and agree to purchase an underlying asset at a certain price on a certain date. The counterpart in this scenario has a short position, which means that it agrees to sell the asset at a certain price on a certain date. (Hull, 2018, p. 6). Future contracts are often defined as a zero-sum game, as one's gains net out their counterpart's losses, meaning that every short position is balanced by a long position. (Bodie et al., 2014, p. 772.)

According to Hull (2018, p. 108), short selling refers to a situation in which assets are not owned but are sold anyway. To illustrate this, here is a certain situation in which an investor decides to short a company X by 10 units. The broker of the deal borrows the stocks from an entity Y (also paying some fee for borrowing the assets) and sells them in the market normally. Later on, the position is closed, and the same investor purchases these 10 units of the same stock X from the markets. These "new" stocks are then used to replace the ones that were borrowed from entity Y. The investor could either earn a profit in this situation if the value of the stock has declined or lose the value of the investment if the stock value has gone up. Therefore, shorting implies that an investor expects investment objects to lessen in value. (Hull 2018. p. 108). Furthermore, Bodie et al. (2014, p. 772) describe short selling and long-position buying as figurative, since the contract itself is not actually sold or bought like a stock or a bond would be. Long and short positions are somewhat mutual agreements when at the time of contract, no money changes hands.

In the scenario described above, payoffs are explained as follows. In a forward contract, the payoffs from a long position on an asset are the difference between the delivery price K and the spot price of the asset in the end of the contract $S\tau$.

$$P = S\tau - K \tag{6}$$

In this case, the holder of the long contract is obligated to buy the asset that is worth $S\tau$ for the price of K. On the other hand, in a short position, the forward contract owner has a payoff resulting from the subtraction of the spot price of the asset $S\tau$. from the delivery price K.

$$P = K - S\tau \tag{7}$$

Payoffs from short and long positions can be negative or positive. These positions are illustrated in the following figure number 1, where the delivery price is K and the price of asset at maturity is St. In theory, a long position enables a situation in which the maximal loss of a position is limited to the price of the option, but the possible gains are limitless. Conversely, a short position provides unlimited losses and limited gains. (Hull, 2018, p. 7).

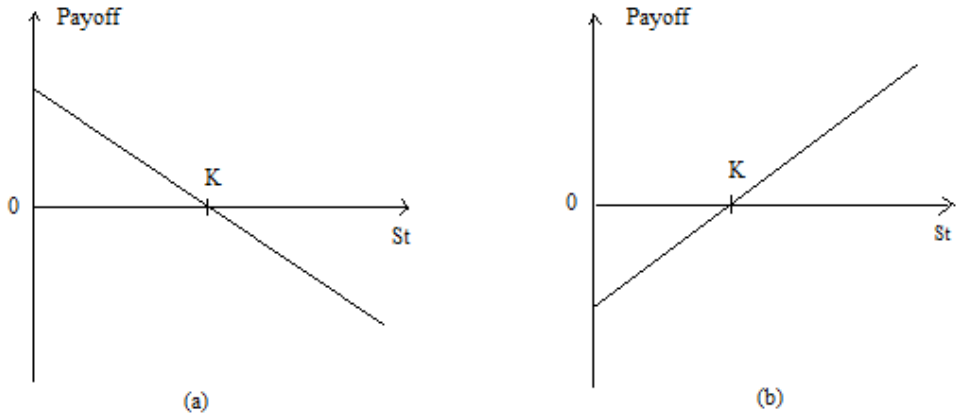

Figure 3. Payoffs of forward contracts (a) short position and (b) long position (adapted from Hull, 2018, p. 7).

Forward options include mainly two types of options: puts and calls. A put option enables the holder of the option to sell an asset or a security at certain price by a certain date, whereas a call option refers to a situation in which the holder has the right to buy an asset or a security at a certain date for a certain price. (Hull, 2018, p. 19).

Options are usually described as either European or American. American options can be exercised whenever until the expiration date of the option, while European options, which are more widely used, are only exercised on the expiration date. The purchaser of a call option will be hoping that the asset's value increases, whereas the purchaser of a put option will hope for a diminishing value of an asset. (Hull, 2018, pp. 209–210.)

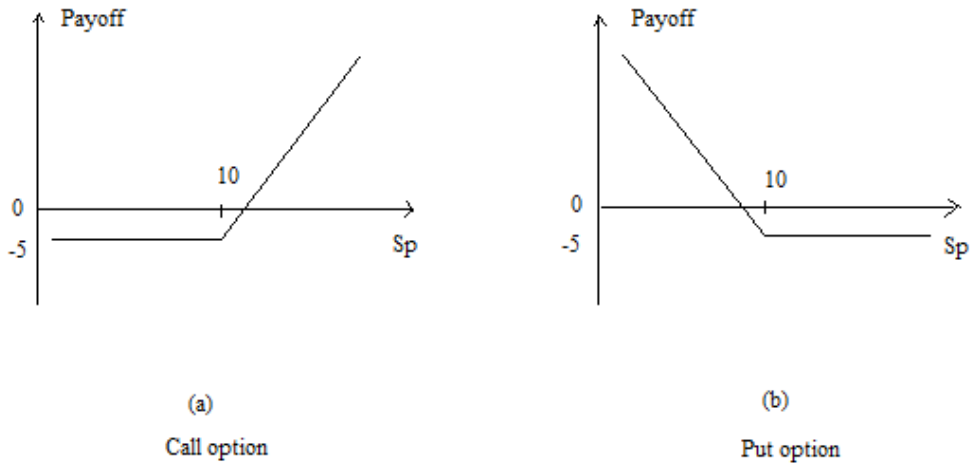

Figure 4. Payoffs of European options (adapted from Hull, 2018, pp. 210-211).

The European call option as displayed in figure 2, can be exercised only on the expiration date. If the underlying stock price (Sp) on this expiration date is under $10 the investor does not choose to exercise the option and will lose its initial investment of $5 for purchasing the option. If the price is over $10, it will be exercised, and the profit is as high as it climbs. As mentioned previously, call option buyers hope that the stock price increases, and they earn profits. On the other hand, buyers of put options are hoping that the stock price will plummet as they earn profits when the stock price (Sp) falls under $10. If the stock price does not fall under $10, the option is yet again not exercised, and the loss of the investor is the initial price of the option. (Hull, 2018, pp. 201-211).

4.2 Macro and managed futures funds

Macro and managed funds invest at the macro level implying the vast scope in this particular fund. These funds commonly manage long and short positions all over the global equity, currency, fixed income, and commodity markets. This particular fund exploits using futures, swaps, and forwards in its investment strategies. Since this strategy of macro and managed futures funds focuses on derivatives markets, they typically own highly liquid holdings which allows them for quick liquidation of holdings in the cases of market crisis. Leverage in macro and managed funds comes as well from derivatives markets, which lessens the probability for counterparty risk. (Chambers et al., 2018, p. 29.)

According to Hull (2018, p. 20), a derivate can be described as a financial instrument whose value derives from the values of other underlying, perhaps more primitive variables. Usually, the variables defining the value of a derivate are the prices of assets such as in stock option. In stock option, the value of derivates originates from the value of a stock that the option is combined with. Nonetheless, derivatives can be combined and dependent on nearly any kind of variables or investment objects. (Hull, 2018, p. 20.)

Chambers et al. (2018, p. 29) show that when investors are allocating their funds between different hedge fund strategies, they should take liquidity and common performance into consideration during times when markets are in crisis. In this sense, what makes macro and managed funds attractive is their tendency to preserve or even increase in value during times of crisis, while other strategies tend to witness losses. Fung and Hsieh (2004) also point out that trend-following strategies tend to blossom when traditional assets are falling in value, which could provide a fruitful source of diversification inside a portfolio with traditional assets.

Macro and managed future funds are similar in the way that they take positions in derivatives markets and operate on a macro level. What makes them distinct from each other are the facts that macro funds are usually anticipatory, discretionary, and concentrated, and that they use mainly fundamental analysis, whereas managed future funds are often referred to as trend followers or CTAs (commodity trading advisers)

that are more reactive, diversified, systematic and take advantage of technical analysis. (Chambers et al., 2018, p. 29.)

According to Chambers et al. (2018, p. 30), macro and managed funds often attempt to gain prosperity from forecasting international money flows across different asset divisions that may cause markets to form extensive directional moves. Global macro funds tend to use fundamental analysis of market conditions to anticipate these moves. Often, managers of global macro funds have some background in macroeconomics and therefore know to analyze how the behavior of for instance central banks may influence currency and sovereign debt markets. Usually, macro hedge fund managers seek trades in which they may witness large hypothetical gains with decreased potential losses. To illustrate this, one commonly used trade among macro managers is shorting a currency that is fixed to a rate that macro funds managers consider to be too high compared to another currency, and therefore is expected to be devalued.

Khandani and Lo (2007) label this certain strategy as "Global macro". Within global macro hedge fund- strategy, the managers tend to carry long and short positions in the global extensive derivative or capital markets. The positions of managers mirror their perceptions of the overall global market movements that are mainly affected by large trends or events in the markets. Global macro hedge funds can for example include bonds, stocks, commodities and currencies. What makes these funds "global" is the fact that they invest internationally in emerging and developed markets.

4.2.1 Managed futures funds or CTAs

Chambers et al. (2018, p. 31) show that managed-future funds usually follow trends in order to seek long positions when the fund manager is anticipating that prices are trending higher, and to seek short positions when lower prices are anticipated. The trading systems of managed future funds are often mostly built by using historical data and the human emotions of greed and fear, which might have an effect on markets. These systems basically determine which markets to sell and which to buy by comparing the current market price patterns and the profitable historical patterns. Bodie et al. (2014, p. 928) further explain managed future funds as a strategy that uses technical trading rules. Chambers et al. (2018, p. 31) add that the investments in assets

of managed future funds usually consist of two-thirds in equity index, interest rate, currency derivates and fixed income, and one-third in agricultural commodity derivates, metals and energy. If we consider the history of managed future funds, they have even experienced gains during the market crisis of 2008. Fung and Hsieh (2004) state that similarly to option buyers, managed future funds tend to gain in value when markets are volatile. Jeanneret, Monnin and Scholz (2010) add that when investing in CTAs (Commodity Trade Advisors) alternatively to traditional long-only investment objects, investors tend to gain superior returns and downside safety.

The biggest concern or risk inside managed future funds is the possibility that markets are not behaving the way they did in the past or are not trending. Moreover, the risk of including computer-based funds is that many similar funds might be using similar systems, which might therefore create crowded trades and distorted market prices. Computer-based trading strategies might also act in unexpected ways and generate rapid losses. (Chambers et al., 2018, p. 31.)

4.3 Event-driven hedge funds

As the name might imply, event-driven hedge funds pursue trades in securities of certain companies that are expected to experience dramatic developments during the advent months. The main focus of these funds lies on mergers, situations of distressed debt, and spinoffs or other changes that might alter the equity or debt architecture of a certain firm (Fung & Hsieh 1999). Typically, event-driven funds profit when the anticipated event occurs as expected. Event-driven managers can focus on a single investment strategy, but many combine the following strategies into an individual fund. The main justification for combining the strategies is that many event-driven opportunities are countercyclical, that is, moving in different directions than their corresponding strategies. (Chambers et al., 2018, p. 31.)

According to (Khandani & Lo, 2007), event-driven strategy is defined as a strategy investing in special situations. This strategy is designed to abduct the benefits from price movements that are generated by pending corporate events. Corporate situations which can benefit from event-driven strategy from are corporate restructurings,

mergers, acquisitions, liquidations of companies and bankruptcies (Bodie et al., 2014, p. 928.)

Merger arbitrage activism is often at its greatest when strong equity markets have strong implications and many possible mergers and acquisitions. On the other hand, for instance, fund managers of distressed debt hedge funds do better when markets are facing turmoil and downturns, since more companies default on their debt obligations as a result of the decline in economic conditions. When a hedge fund manager invests in numerous different event-driven strategies, the fund is likely be less volatile and the returns are higher, since the level of diversification of the investments is improved. (Chambers et al., 2018, p. 33.)

4.3.1 Merger arbitrage

According to Fung and Hsieh (2004), merger arbitrage can also be defined as risk arbitrage. In this specific strategy, investors simultaneously invest in each company involved within the merger or acquisition. A typical situation in this strategy is to have a long position in the stock of the acquired company, and a short position in a stock of the company that is acquiring the first company. Within this strategy, the main risk emerges from deal risk, which implies the possible scenario of a merger-contract not getting fulfilled as expected. (Khandani & Lo, 2007.)

Fung and Hsieh (1999) show that in a merger arbitrage, funds typically aim to take a long position inside the equities of the target firm and a short position in the acquiring firm, usually after the possible acquisition of two companies is announced. Occasionally, this situation is reversed if the hedge fund managers anticipate that the merger deal might fail. The biggest risk within this strategy lies in a situation in which the announced merger is not fulfilled (for instance when regulators or managers do not accept the terms of a merger). The potential decline is also considerably huge if the anticipated merger is not fulfilled, and it often leads to a vast decline in the share price of the target firm. Performing this particular fund-strategy depends a lot on the fund managers' ability to forecast the potential mergers and typically, merger-arbitrage funds are blooming when the overall market conditions are healthy and the merger

activity level is high. Therefore, this strategy does not do well in the event of financial crises. (Chambers et al., 2018, pp. 31–32.)

4.3.2 Activist-, and distressed hedge funds

Activism among investing generally means seeking opportunities to influence the results of an investment. Activist hedge funds can for instance promote an agenda that might result in changes in the manner this hypothetical firm is managed, such as changes in the composition of the board or in the capital structures of this firm. Activism can be categorized as friendly or hostile. Friendly activism includes for instance working exclusively with corporate management, and hostile activism usually means publishing an own agenda about the company or openly criticizing the board of a company about the way they are managing it. Activist hedge funds tend to contain highly concentrated portfolios that are often less hedged against market risk (systematic risk). The largest risks when considering investments in activist-hedge funds are the failure of the activist to make positive changes in the object firm and the declining equity markets. (Chambers et al., 2018, p. 32.)

Distressed hedge funds aim to invest in securities or corporate bonds of a firm that has announced bankruptcy or is prone to experience a rapid decline of financial performance (Fung & Hsieh 1999). Investments in securities of distressed firms are very complex and illiquid. Distressed hedge fund managers tend to have a financial background which helps them estimate more accurately the recovery value of a firm and its assets. To illustrate distressed strategies more thoroughly, some funds invest in long-only positions in different debt securities, while others may employ capital structure arbitrage, in which managers buy one security and short sell another security inside of the same firm. Distressed hedge-fund investments include numerous risks such as illiquidity, the complex nature of the securities of defaulting firms, credit risk and dropping values of firms issuing securities. (Chambers et al., 2018, pp. 32–33.)

According to Khandani and Lo (2007), the managers of distressed hedge fund strategies invest in debt/equity or trade requests of companies that are in financial distress or in bankruptcy. Typically, companies that are in major difficulty and have needs to revive their financial balance, such as in cases of bankruptcy, trade their assets

with great discounts. Hedge fund managers might perceive this as a possibility to turn over the assets bought cheaply.

4.4 Relative value funds

Relative-value hedge funds target the convergence in the prices of comparable or related securities. As with event-driven funds, relative-value funds can also lose money quicker than they generate it. Convergence strategies usually benefit in stable market conditions, especially when volatility is declining, and credit spreads are tightening. On the other hand, in the case of market turbulence, relative value funds may experience extreme losses. When the event of a market crisis not considered in successfulness of this strategy, relative-value funds generate significant profits and low volatility. (Chambers et al., pp. 33–34.)

Relative-value funds usually include one of the following strategies or a combination of them: fixed-income arbitrage, convertible-bond arbitrage, volatility arbitrage or relative-value multi-strategy, which is the combination of strategies. Usually, relative-value funds trade by applying multi-strategy preferences rather than only focusing on one specific strategy (Chambers et al., 2018, p. 35).

4.4.1 Convertible arbitrage

According to Khandani and Lo (2007), convertible-arbitrage strategy can be identified as an investment in the company's convertible security. Bodie et al. (2014, p. 928) also explain that this strategy is typically achieved by holding the convertible bond as a long position and the common stock of the company as a short position. Profits within this strategy are gained through fixed-income securities and short sales of stock. Agarwal, Fung, Loon and Naik (2011) show that even though the popularity of convertible-arbitrage (CA) hedge funds has rapidly increased, according to TASS Asset Flow Report, the overall coverage of assets employed across all hedge fund strategies between 1993 and 2007 was merely around 4,51%.

For instance, a convertible bond might offer the possibility to gain interest and principal payments or the possibility to change bonds to stocks, by for example paying

10$ per share. For illustrational purposes, let´s assume that the stock value stays under 10$ per share, in which case investors would rather receive coupon-payments and the principal payment. If the stock tops the price of 10$ per share at maturity, investors will probably select to receive the shares rather than the face value of debt. In this situation, investors pay for this option by accepting lower bond yields for their investments. (Chambers et al., 2018, p. 35).

According to Chambers et al. (2018, p. 34), convertible bonds are often very complex and illiquid, especially when the bond in question is puttable, callable or has some mandatory conversion characteristics. Given this perception of complicity and illiquidity in convertible bonds, there are higher possibilities for mispricing, which then opens possibilities for arbitrage. As explained before, convertible-arbitrage hedge funds usually try to find cases in which the embedded equity-option seems to be underpriced. In this case, the hedge fund purchases the convertible bond and at the same time short sells the underlying stock of an amount particular to hedge against the risk of underlying movements of stock price. The risks involved with convertible arbitrage strategy are first of all model risk, in which the valuation and hedging models do not accurately reflect the valuation or the risks of the underlying securities and strategy, and second of all, the risk involved with using leverage, as convertible-bond hedge funds are highly leveraged. (Chambers et al., 2018, p. 34). Agarwal et al. (2011) show as well that convertible-arbitrage strategies are sensitive to times when markets are in turmoil, such as in the case of the LTCM (long-term capital management) crisis in 1998.

4.4.2 Volatility arbitrage

Volatility-based hedge fund strategies concentrate on changes in volatilities and the difference between expected- and realized volatilities. Volatility-based strategies mainly focus on equity-price volatilities and apply futures contracts and exchange-traded products on this implied volatility. Volatility-arbitrage hedge funds aim to profit when options are possibly mispriced in relation to each other, or when these options are mispriced in relation to movements in the underlying securities. Most hedge fund managers aim to purchase underpriced options, sell options that are overpriced and, by combining these two elementary strategies, earn superior profits. Simultaneously,

hedge fund managers hedge the option positions by offsetting the positions in the assets that are underlying the options. Another common trade in this strategy is one called the “dispersion trade”, in which the goal is to offset the position in equity-index options by using options of stocks within that same index. Volatility arbitrage introduces a feature called “correlation trading”, in which the hedge fund takes long positions in options of individual stocks and short options in indices, which enables them to profit when the correlation of these two diminishes. Volatility-based hedge funds mainly display large gains when markets are in crisis but gravitate low returns or even losses during times when markets are quiet. (Chambers et al., 2018, pp. 34–35.)

4.4.3 Fixed-income arbitrage and relative value multistrategy

Fixed-income arbitrage attempts to profit from changes over time in the yield relationships of investment objects. In this strategy, a fund manager obtains offsetting short and long positions in for instance any fixed-income securities, derivatives including investment-grade and high yield bonds, sovereign debt, MBS, credit default swaps and securities filled with assets (Chambers et al., p. 35). Consequently, fixed-income arbitrage strategy aims to profit from anomalies between interest-rate securities that are related to each other (Khandani & Lo, 2007). In order to illustrate fixed-income arbitrage strategy, Bodie et al. (2014, p. 928) mention that interest-rate swaps are often used, as for example between U.S. and non-U.S. government bond arbitrages.

Fixed-income arbitrage strategy can be viewed as simple but also, on some occasions, riskier than others. The simple aspect might include offsetting long and short positions in a sovereign yield curve. A riskier example of fixed-income arbitrage strategy would be to carry a trade where the investor or hedge fund manager invests in high-yielding securities and uses for instance derivates and sovereign debt in order to hedge the interest rate risk. In consideration of crisis behavior, this strategy tends to be fruitful when market conditions are normal and credit spreads are in stable conditions. If credit spreads increase rapidly, the damage to the hedge fund value can be significant, since this strategy uses a lot of leverage and the costs of financing might increase. (Chambers et al., 2018, p. 35.)

According to Chambers et al. (2018, p. 35), relative-value multistrategy funds can invest in a broad selection of relative-value trades, including convertible bond arbitrage, fixed income arbitrage, and volatility arbitrage. Many of the relative-value hedge funds trade using a multistrategy rather than focusing only on one. Khandani and Lo (2007) mention that in the context of the beginning of the global financial crisis in 2007 relative-value strategies displayed that many existing measuring methods for estimating risks, such as illiquidity and volatility risk were not adequate for this certain strategy.

4.5 Equity hedge funds

Bodie et al. (2014, p. 928) argue that depending on the market perceptions, equity-oriented positions are usually on either side of the market (short or long) and are not meant to be market neutral. These funds may take concentrated, industrial, or regional focuses in order to establish equity/short positions in the markets.

Hedge fund managers attempt to sell overvalued short stocks while simultaneously trying to obtain long positions in shares or stocks they believe are cheap or undervalued. What mainly differentiates equity hedge fund strategies from each other is their net market exposure. Long-short funds are typically net long, market-neutral funds are usually entirely hedged against market movements, and short-selling funds are net-short, which implies that they behave comparably well when markets are declining (conversely to net-long funds which operate well when markets are climbing). What needs to be taken into consideration within this strategy is the fund's beta risk, as the investor might have some other investments that correlate highly with the investment objects within this strategy. Equity hedge fund managers usually use either a quantitative approach or a fundamental stock-choosing one. Fundamental managers thoroughly research the company and its assets or profitability, and usually maintain a quite narrow number of positions. On the other hand, quantitative managers will pursue a more diversified portfolio including many positions. (Chambers et al., 2018, p. 35.)

4.5.1 Long-Short equity funds

According to Chambers et al. (2018, p. 36), long-short equity funds are rather more long-position balanced than short, and they can be referred to as Equity Long Biased hedge funds. In an ideal situation, the manager of an Equity Long Biased hedge fund adds alpha from both long and short stock choices, and when investors assess the funds, they should assess the manager's skills by their choices of short and long securities. Long positions are typically held over a longer period of time, and their potential gain is usually much higher than their potential loss, since the only possible loss of money is the initial investment, but the investment or stocks value can climb as high as possible. Short positions work in the opposite way. (Chambers et al., 2018, pp. 35–36.)

The hedge fund strategy described as "balanced between stocks and bonds" is a subtype of net-long exposure hedge funds. The goal of this strategy is to limit the volatility of the overall hedge fund portfolio by taking advantages through diversification, by blending asset classes with low cross-correlations. (BarclayHedge, 2020).

According to Joenväärä, Kosowski and Tolonen (2012), Long/Short strategies are the largest hedge fund style in common databases: for HFR, it represents 29,8% of the total funds, for TASS 35,6%, for Morningstar 32,5%, for BarclayHedge 20,8% and for EurekaHedge 29,8%. Long/short equity fund- strategies include investments in equity while using both long and short investments in the markets. The objective within this strategy is to avoid holding market-neutral positions, and the managers of the funds require the skills to make shifts in their holdings, from long to short or from large to small capitalization of stocks. Hedging within this strategy is usually managed through futures and options. (Khandani & Lo, 2007.)

4.5.2 Short-selling equity funds

According to Bodie et al. (2014, p. 928), short-selling equity hedge funds are often described as a dedicated short bias within hedge fund databases. Short-selling equity funds can target a portfolio that focuses on short selling or target a long-short position

that is net-short of 50%. Short equity fund managing and maintaining can be rather challenging, as markets in a normal situation tend to climb in value, and this particular fund should be used in a portfolio to hedge against long stock positions. What makes short-selling equity hedge funds tempting is the tendency for the competition of long trades and short trades to be asymmetric. Stocks are mainly held long, and there are less than 10% of shares held short. This implies that many investors seek to buy or invest in long positions of undervalued stocks, but fewer investors seek to sell short, overvalued ones. This reduced competition might in theory provide increased alpha for the hedge fund managers that are short sellers. (Chambers et al., 2018, p. 37.)

4.5.3 Sector hedge funds

Sector hedge funds concentrate their investments in a specific sector of the economy rather than in a particular investment object. Hedge fund managers using this strategy rely on their thorough knowledge of an industry combined with their connections within that industry. Sector hedge-fund style is often described as a risk-seeking strategy with a great potentiality for sizable profits. (Fung & Hsieh 1999.) According to BarclayHedge (2020), sector-specific hedge funds include sectors such as environment, energy, farming, health, mining, natural resources, real estate, and technology.

4.5.4 Emerging markets hedge fund

The Emerging markets- hedge fund strategy mainly involves equity or fixed-income investments towards emerging markets globally. Investing in emerging markets is often managed through long-only investment strategies, since it is quite common that emerging markets do not enable short selling or offer any other possible derivative products that a hedge fund could hedge upon. Unfortunately, since investments within this strategy are prone to long-only investments, it is vulnerable to movements caused by financial crises. (Khandani & Lo, 2007).

Hull (2018, p. 12) further explains that the hedge fund strategies for emerging markets typically invest in debt and/or equity inside companies originating from developing countries. Bodie et al. (2014, p. 928) add that typically, the goal within this strategy is

to take advantage of the market inefficiencies within emerging markets. This particular strategy usually pursues long-only investments, since short-selling is not achievable in most emerging markets.

According to Aggarwal and Jorion (2010), emerging markets- hedge fund managers have very strong financial motives to add value for investments performance, and since their size is often much smaller than already established traditional hedge funds, they are consequently more agile. Even when hedge fund- related biases are taken into consideration, emerging markets- hedge fund strategies seem to show strong exceeding performance in the beginning of their existence.

Jiang and Kelly (2012) show that a good way for new and young emerging markets hedge funds to establish returns is to take on investments that are tilted towards tail-risk, as they tend to carry a high compensation for risk. Aggarwal and Jorion (2010) also clarify that the first two years of existence within emerging markets- hedge funds-strategy especially tend to establish create opportunities for investments. Also, what might make this strategy attractive is its tendency to be open to new investors as well, unlike older hedge funds.

4.6 Market neutral hedge fund strategies

Market-neutral equity hedge funds stabilize the risk and size of their long positions by the risk and size of their short positions. This way, the hedge fund aims to operate in a situation of zero beta and zero directional exposure to stock markets. As is typical for all equity hedge funds, this particular strategy relies mostly on the manager's ability to choose an investment object, as the hypothetical return of the fund is entirely made from their skills for selecting stock. (Chambers et al., 2018, p. 37.)

According to Khandani and Lo (2007), the equity market-neutral hedge fund strategy aims to take advantage of equity market inefficiencies. Bodie et al. (2014, p. 928) also argue that the exploitations of these market inefficiencies are usually managed through the control of for instance industries, sectors, size, and other exposures in the markets. Usually, this strategy involves equal-sized simultaneous long and short positions within matching equities. Market-neutral equity hedge funds are designed to be

currency and, - or beta neutral, with the tendency to include plenty of leverage in order to enhance possible returns. (Khandani & Lo, 2007.)

According to Patton (2009), hedge funds are usually categorized according to their investment strategies or styles. The equity market-neutral hedge fund strategy is one of the largest strategies among hedge funds, since about 20% of all hedge fund strategies are covered with market-neutral styles. The goal of market-neutral hedge fund styles is to "neutralize" market risks by taking differing short and long positions in securities that are related. Neutrality within hedge funds is often based on correlation or market-beta, implying the uncorrelation of possible generated returns, for instance with some market index. Therefore, one of the main attractions in market-neutral hedge fund styles is their independence between the fund and the market.

4.7 Fund of Funds

The "Fund of funds" hedge fund strategy invests in other hedge funds. According to Bodie et al. (2014, p. 946), the main idea within Fund of funds is to distribute the risk between several different hedge funds. Chambers et al. (2018, p. 43) argue that investing in FoFs includes many positive and negative aspects. One positive aspect of FoFs is their accessibility to even small investors that do not have the knowledge, the time or the typically huge minimal investment required by other hedge funds to gain a profound level of diversification in hedge funds. The mitigated effort for necessary due diligence is therefore the most notable benefit within this strategy. In addition, FoFs tends to include many large-scale benefits, such as their superior negotiating abilities for fee construction and liquidity terms.

Bodie et al. (2014, p. 944) show that the main downside with the FoFs strategy is the option-like compensation of their fees, as the incentive fee is paid to each underlying fund that outperforms its benchmark. Fees are even paid when the accumulated performance of the fund of funds is not superior to the aggregate performance. Chambers et al. (2018, p. 43) add that even when Fof´s fees are subtracted, these particular funds tend to underperform direct hedge fund investments.

4.8 Proportion of hedge fund strategies in databases

In this thesis, hedge fund categorization is established according to the proposition made by Joenväärä et al. (2012) as follows. 12 main categories of upper hedge fund strategies are examined in this thesis: Event Driven, CTA, Global Macro, Emerging Markets, Long/Short, Market Neutral, Long Only, Multi-Strategy, Short Bias, Relative value, Sector and Others. In addition to these, 5 subcategories of strategies are introduced in the data-sample of this thesis. Figure 5 displays the proportions of these hedge fund strategies in five different databases at end of 2011 and according to Joenväärä et al. (2012). The data is gathered from the following databases: Hedge Fund Research (HFR), Lipper TASS, BarclayHedge, EurekaHedge and Morningstar. Joenväärä et al. (2012) show that there are differences in the data base's assets under management, coverage in returns and in the amount of defunct funds per database. For instance, the number of hedge funds across different databases ranges from 7,502 (Morningstar) to 10,520 units (BarclayHedge), and TASS, HFR and BarclayHedge contain more obsolete funds than alive funds, which suggests strong biases of backfilling and survivorship. The following figure displays the hedge fund strategies in detail.

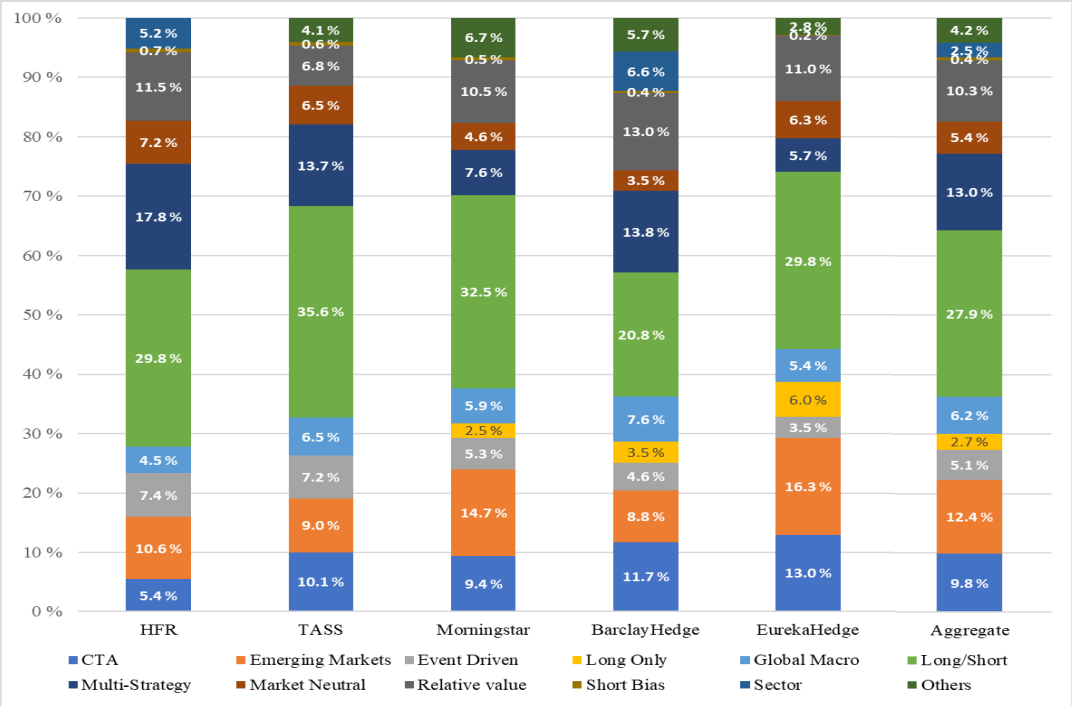

Figure 5. Proportion of different hedge fund strategies (adapted from Joenväärä et al. 2012).

5 EMPIRICAL DATA AND METHODOLOGY

5.1 Description of Data

This chapter will present an analysis of the overall data regarding hedge funds and of the data used within this study. The data is collected from BarclayHedge over the period from January 1997 to November 2020. BarclayHedge is an enterprise specialized in providing reliable information as well as data regarding the performance and other vital characteristics of hedge funds, and it is considered as one of the most prominent sources for conducting research about hedge funds. The data in the BarclayHedge database is formulated by using hedge fund indices that include several different individual hedge funds in order to capture the real essence of hedge fund-related features. Monthly returns of indices only include returns of funds that report their data monthly.

The BarclayHedge database for hedge fund indices includes the 18 different main allocations for hedge fund strategy indices that should be included whenever conducting studies about hedge funds: Barclay Hedge Fund, Balanced (Stocks & Bonds), Convertible Arbitrage, Distressed Securities, Emerging Markets, Equity Long Bias, Equity Long/Short, Equity Market Neutral, European Equities, Event Driven, Fixed Income Arbitrage, Fund of Funds, Global Macro, Merger Arbitrage, Multi strategy, CTA /Managed Futures, Option strategies and others. The Barclay Hedge Fund- index combines all the hedge fund indexes included in the data sample, since it includes 2933 different funds with different categorizations as of in the end of 3rd Quarter of 2020. The hedge fund indices described as “others” include a combination of smaller categories of different hedge fund indices that are not accepted as part of the multi-strategy subcategory. Other strategies included in this data sample are described in full detail in chapter 4.

The data of the 18 different strategies of hedge fund indices includes the monthly net-of-fee returns between January 1997 and November 2020. The timeframe is that extensive in order to capture as many financial crises affecting hedge fund performance as possible. In this study, the three Fama/French Factors (FF3) are employed for estimating and evaluating the market returns simultaneously during the

period of 1997 – 2020. The Fama/French factors "$Rm - Rf$" as the excess return on the market, represents the value-weight return calculated from commonly known CRSP firms. These firms are incorporated in the United States and listed on the AMEX, NASDAQ, or NYSE minus the one-month U.S government Treasury bill rate as a representative of the risk-free return available in the market. Hence $Rm - Rf$ gives a great and reliable benchmark for comparing different hedge fund return in the U.S market between 1997 and 2020. (French, 2020).

As previously mentioned in this thesis, regulatory requirements for hedge funds are different from the ones faced by mutual funds and other investment vehicles. What makes hedge fund- related data even more difficult to analyse is the fact that databases and hedge fund- related data are often provided voluntarily by the funds themselves, which, in some cases, render them questionable. Therefore, the question about the rationale for an inadequately performing hedge fund to report its data to the public should be addressed before examining hedge funds or their data.

According to Agarwal, Fos and Jiang (2013), hedge funds have vastly liberated themselves from the regulations normally faced by great financial institutions such as mutual funds and banks by raising capital through private placement. Due to their light regulation, hedge funds are not enforced to report their information or data about their strategies, performance and characteristics to any database or authorities. This makes hedge funds the least transparent participants in the markets. Liang and Park (2010) add that defining hedge fund failures is difficult since gaining detailed information about defunct or dead hedge funds is challenging.

According to Agarwal et al. (2013), the reporting tendencies of hedge funds should be defined as a cost-benefit trade-off. In some cases, reporting can be fruitful, and in others, it is more costly than beneficial. When a new hedge fund is emerging in the markets, listing it in a database can improve a fund´s availability for new investors. On the other hand, the main cost and downside of reporting originates from a partial loss of that hedge fund's privacy and secrets. From a hedge fund's point of view, the least favorable situation would be to continue reporting commitment and revealing information a fixed time period during fixed intervals, which would dispose the hedge fund's ability to operate in a flexible manner almost entirely. (Agarwal et al., 2013.)

5.2 Hedge fund data biases

Hedge fund databases are commonly known to include several biases. Chambers et al. (2018, p. 46) show that many database- related biases within hedge funds usually appear to decrease the risks of investing in hedge funds or to increase the potential gains. According to Fung and Hsieh (2000), it is well known that hedge fund- related databases contain numerous biases and that the information on hedge funds is not easily accessible. These biases are mainly caused by the previously mentioned deficiencies in requirements for disclosure, as hedge funds have the ability to choose whether they report their return characteristics to the databases or not. Hedge funds are defined as private investment vehicles and therefore simply are not required to disclose their data.

Hedge fund biases can be categorized as natural or spurious biases. Spurious biases are mainly created by using statistical means to bypass data deficiencies, and natural biases emerge from hedge funds- related natural birth, prosperities, and deaths (Fung & Hsieh, 2000). Titman and Tiu (2011) suggest that the most notable hedge-fund related- biases are survivorship bias, self-selection bias and backfilling bias.

5.2.1 Survivorship bias

Fung and Hsieh (2000) show that survivorship bias is the difference in performance between the observable funds and the surviving ones. Chambers et al. (2018, p. 47.) argue that when liquidated hedge funds are compared with the ones that are still reporting to databases, the liquidated ones are assumed to have higher risks and a lower return. Since many hedge funds have a lifespan of three to five years, the survivorship bias poses a significant issue. On the other hand, Feffer and Kundro (2003) argue that the failure of a hedge fund should be separated from nonobligatory fund liquidations, since they are more frequent and are usually driven by the hedge fund manager's market expectations. Feffer and Kundro (2003) define failing hedge funds as those that have been forced to discontinue investment operations due to reasons outside the hedge fund management´s jurisdiction. Joenväärä et al. (2012) add that remarkable differences in survivorship bias among different databases influence the average

performance of funds, since the funds surviving among databases tend to include greater returns than the defunct ones do.

Ibbotson et al. (2011) also explain that failed funds are usually deleted from databases. The difference between surviving and obsolete funds can be interpreted from the way they report their returns. As databases only include information from funds that do report it, these funds are described as the ones surviving. Obsolete funds might have stopped reporting their data to databases for numerous reasons, such as liquidations, mergers, poor performance, bankruptcies or for voluntary reasons. If the funds become defunct or obsolete from the database due to poor performance, the performance of the surviving funds is heavily biased upwards, and the typical experience from investing in hedge funds gains an extra positive, biased, and false output. (Fung & Hsieh, 2000.)

Fung and Hsieh (2000) show that according to the TASS database, 60% of the 602 defunct hedge funds were liquidated, 28% were obsolete because their managers had stopped reporting the return characteristics, 4% were merged and 8% were defunct for undisclosed reasons. Defunct funds performed worse than the ones categorized as the surviving ones, and the liquidated funds had substantially lower return characteristics than other defunct funds. Liang (2000) continues by studying the existence and the magnitude of survivorship bias for hedge funds in the TASS and HFR databases. According to this study, the annual survivorship bias of hedge funds averages a bit over 2%, a result consistent with the findings made by Fung and Hsieh (1998).

Fung and Hsieh (2009) point out that earlier studies about the magnitude of hedge fund biases could be faulty or misleading since many performance measurements of biases might be affected by two errors. The first error refers to the situation in which hedge funds migrate from one database to another and the second error occurs if are databases merged together. According to Titman and Tiu (2011), the survivorship bias was a major issue within the data gained before 1994 since databases simply discarded the funds that had discontinued reporting their information. In order to mitigate the survivorship bias, the term “graveyard sample” was included in hedge fund databases after 1994. This sample included the prior returns of funds that had ceased reporting. On the other hand, Liang and Park (2010) argue that on average, liquidated hedge funds tend to have lower downside risks than the median hedge funds in the graveyard

sample. Liang and Park (2010) add that simpler measurements, such as a change in a fund's size and performance provide more value to define the failure of a hedge fund than the reasons provided by data vendors do.

5.2.2 Backfilling or instant history bias

When hedge fund- related returns are first reported to a database, the years prior to the reporting are all added at once, while the later records of the fund are reported in real time, for instance monthly. A common aspect of returns is the tendency for the live monthly records of the funds to appear unimpressive compared to the returns initially reported (Chambers et al., 2018, p. 47). Titman and Tiu (2011) argue as well that since backfilling the historical data of a hedge fund is not compulsory when they enter a database, this may cause an upward bias in the characteristics of the reported return, as there is no motive for a fund to backfill its performance if it has been lousy. In order to mitigate this issue, Titman and Tiu (2011) recommend eliminating from the data-history the first 27 months of all the funds that are prone to backfilling biases. Problems related to backfilling-bias seem particularly strong if a manager of many hedge funds is able to launch them simultaneously and then only reports the returns of the funds that were successful. The results provided by Titman and Tiu (2011) are consistent with the study made by Jagannathan, Malakhov, and Novikov (2010) in which the recommended optimal number of months to be excluded from the database is 25.

According to Fung and Hsieh (2004), when funds enter a database, their prior history is affixed and many funds with a good track record enter a database in order to seek new potential investors and advertise themselves legally by doing so. Fung and Hsieh (2000) point out that funds with an only favorable past performance and managers with a good performance record have incentives to report to a database. On the other hand, funds suffering losses will have no incentive to report their poor track records to a database. Joenväärä et al. (2012) argue that the difference in backfilling bias among databases influences the persistence of hedge funds performance since incompetent obsolete funds tend to underperform.

Posthuma & Van der Sluis and Pieter Jelle, (2003) show in their study that the average length of instant histories is actually 37 months, which is considerably longer than the

estimates from other above-mentioned researchers. In addition to this and according to Posthuma et al. (2003), over 50% of all returns inside the TASS database are backfilled. When comparing the different strategies, Fund of funds, which is often described as the most bias-free, witnessed a backfilling bias of 2,27% per annum. If these 50% of backfilled returns are omitted from the data, only five hedge fund strategies were able to deliver positive returns in the time period from 1996 to 2002: convertible arbitrage- strategy 3,5%, long or short equity hedge 2,9%, event driven 5,5% and equity market neutral strategy 3,6%. (Posthuma et al., 2003.)

5.2.3 Multi-period sampling bias

According to Fung and Hsieh (2004), various hedge funds include differences in sampling. For instance, when TASS and HFR databases are compared, the former has 396 funds that are not within the other databases and the latter 446. Fung and Hsieh (2000) define multi-period sampling bias as the result of the requirement for a sampling period, according to which hedge funds should have a sufficient history before being included in a study. For example, an indicative period of time for the returns data of a hedge fund to become suitable to be studied or after to be invested in could be 24-months to 36-months. This implication can be difficult in some situations, for instance when considering the many emerging and new funds which do not have a track record of 24 to 36 months: excluding them from the dataset could make it faulty. Fung and Hsieh (2000) report that a multi-period sampling bias is actually relatively small, as the required 36-months of minimum history generates a 0,6% of chance in results.

5.2.4 Misreported returns bias

Bollen and Pool (2009) show that many hedge funds are more likely to report extremely small gains than small losses, which could lead them to report every positive movement in the data that is above zero. This suggests an intentional distortion of returns on the managers' part, meaning that they purposely avoid reporting any small losses. The distortion prompted by the discontinuity in reporting returns is instant in defunct and in existing funds, which suggests that this bias is not a feature of the survivorship bias.

An alternative explanation for the discontinuity in reporting returns is that managers might simply be overly optimistic in regard to the valuations of the illiquid investments occupied in their portfolios. For example, the previously mentioned hedge-fund strategy that specializes in investing in distressed securities shows more discontinuity in reporting than other strategies. If hedge-fund returns are actually distorted, and managers purposely only report positive returns to hide losses, investors may underestimate possible losses of investments and grossly underestimate the efficiency of hedge fund managers. In these cases, investors should be careful when assessing hedge fund performance metrics based on prior positive returns, as they might be unreliable. (Bollen and Pool, 2009).

5.2.5 Self-reporting and smoothed returns bias

A self-reporting is one that originates from the option hedge funds have to stay unreported to any database or to only report occasionally. The common reasons for hedge funds to do so are that they are being liquidated and closed for new investments. A self-reporting bias can possibly affect any study of hedge fund performance and risk aspects. (Agarwal, Fos & Jiang, 2013.)

Titman and Tiu (2011) show that when reporting the results is voluntary, failing hedge funds have no reasons to report. When a fund is excellent, it closes fast and has no reasons to advertise by reporting its characteristics. Agarwal et al. (2010) additionally examine this bias by stating that the performances of non-reporting and reporting hedge funds do not actually differ significantly, but that the funds which report seem to experience losses in performance between the beginning and the end of the reporting period. Titman and Tiu (2011) show that many hedge funds display a positive correlation which is connected to smoothed returns within hedge funds. In the case that returns are indeed smoothed, their Sharpe as well as their information ratios will be yet again biased upwards, which can be interpreted as the smoothed returns- bias.

5.2.6 Biases related to fund of funds

Fung and Hsieh (2000) argue that one way to mitigate many data biases is to use the return data from Fund of hedge funds, or FoF, since it is less prone to include database-

related biases. Fung and Hsieh (2000) also note that when a fund that FoF has invested in has gone defunct, its past performance is still included in the FoF, which then mitigates the survivorship bias. In addition to this, if a fund that is part of FoF does not report to any database, the performance is still compared to the overall performance of FoF. Fung and Hsieh (2004) point out that when Fund of Funds invests into a certain hedge fund, the history of that hedge fund is not included into the history of the entire FoFs´ returns, which therefore restricts the possibility for backfilling returns and for an instant history bias.

5.3 Other hedge fund indices related issues

According to Fung and Hsieh (2004), another deficiency in hedge fund indices, both fund of hedge funds and in individual funds, is that decent hedge fund-related data usually starts after the 90s. As the 90s were merely bullish markets except for few years of market recession, the data related to hedge funds returns do not give a sufficiently long history to determine whether returns were a sign of hedge funds performance or overall market conditions.

Fung and Hsieh (2004) also mention the disadvantage of the hedge fund indexes lacking transparency. As previously mentioned, hedge funds are defined as private investment vehicles and therefore their requirements for disclosure are not transparent. This factor makes analyzing hedge fund characteristics even more difficult, as the only data available is the one they decide to report into a database. In addition to this, the usual benchmarks or various ways to examine portfolio success do not apply well to hedge funds. Equally weighted index returns do not apply, since the distribution of assets in hedge funds is skewed in favor of the top funds, meaning that under 25% of all hedge funds manage over 75% of the entire hedge fund industry. Equally weighted indices also tend to be biased towards newly added funds amid which the backfilling bias is strong. Fung and Hsieh (2004) add that using AUM (asset under management) as weights for hedge fund indexes may cause problems. Using AUM as weights will more likely bias index returns towards less-leveraged managers and aggravate asset-gatherers.

5.3.1 Mitigating Biases

Fung and Hsieh (2000) argue that mitigating the backfilling bias of a hedge fund is possible by deleting some amount of the fund's initial returns from the data. According to their estimates, mitigating can be achieved by estimating the incubation period, i.e., the lag between the initiation date and the date the hedge fund enters into a certain database. The average incubation period is estimated to be 343 days; therefore, Fung and Hsieh recommend deleting the first 12 months of a hedge fund's returns from the data sample. In this study, the original data of many hedge fund strategies begins in 1994, but the initial 36 monthly returns are left out for each of them, as suggested by Posthuma et al. (2003). Therefore, the data sample used within this study starts from 1997. According to Joenväärä, Kaupila, Kosowski and Tolonen (2019), research regarding hedge funds should include the post- 1994 data in order to mitigate survivorship bias.

5.4 Summary Statistics

Table 1 displays the summary statistics of monthly returns for 18 different hedge fund strategies during the sample period of January 1997 – November 2020. Most strategies have the entire sample of 287 months between 1997 and 2020, but Balanced and Option strategy funds have less, due to these funds being listed afterwards. The statistics from table 1 show superior returns for all hedge fund strategies during the previously mentioned sample period.

The mean measures the average monthly returns of hedge funds and the standard deviation represents the dispersion in values. During this time sample, the highest monthly average returns are generated by Equity Long Bias funds while the lowest are generated by CTA hedge funds, Funds of Funds, Market Neutral and Balanced hedge funds. Standard deviation is highest for the Emerging Markets funds and lowest for the Market Neutral funds. On the other hand, the highest AUM, when excluding the Barclay Hedge fund index since it represents the combined data of the whole hedge fund industries, is in Fixed Income Arbitrage funds and lowest AUM is in Distressed hedge funds. Hedge funds pursuing the Convertible Arbitrage strategies only take a small part of the entire sample as they only represent 14 of the 2553 funds, whereas

the Fixed Income strategies have the most operating funds, in the amount of 514. The lowest monthly returns among these 18 hedge fund strategy indices are in Market Neutral funds with the possible loss of -0.029, whereas the greatest losses during this time sample are in the Emerging markets funds (-0.194). The highest positive returns during the time sample between 1997 and 2020 are presented by Emerging Markets, European Equities and hedge funds categorized as others.

Kurtosis measures the likelihood of extreme values on both sides of the mean value. It demonstrates the probability of extreme low or high values; hence investors usually prefer negative or low kurtosis (Bodie et al. 2014, p. 1052). In table 1, Fixed Income Arbitrage and Convertible Arbitrage funds have high kurtosis values (45.4 and 22.7) which indicate the unpredictability of these returns between 1997 and 2020. The lowest kurtosis, with quantities ranging from 1.009 to 2.102 is in the CTA, Global Macro and Equity Long Bias funds, which indicates to some extent a predictability in returns.

Skewness is a measure of asymmetry in the probability of distribution of the returns (Bodie et al. 2014, p. 1057). Positive skewness shows that a superior quantity of returns, in this particular occasion monthly returns, is positive. Vice versa, if skewness is negative, it indicates that a relatively superior share of returns is negative. From table 1 we can analyze that positive skewness is found in Long/Short, Market Neutral, European Equities, CTA and Other strategies and that the highest level of negative skewness is among Fixed Income Arbitrage, Convertible Arbitrage and Multi Strategy hedge funds during the entire time sample.

Table 1. Summary statistics of hedge fund strategies monthly returns, number of funds and AUM.

	Hedge fund strategies								
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities
Mean	0.007	0.004	0.006	0.006	0.007	0.008	0.007	0.004	0.007
Median	0.007	0.005	0.006	0.009	0.011	0.009	0.006	0.004	0.007
Std. dev.	0.021	0.019	0.017	0.020	0.039	0.033	0.020	0.009	0.022
Var	0.000	0.000	0.000	0.000	0.002	0.001	0.000	0.000	0.001
Kurtosis	4.127	5.064	22.658	3.880	3.801	2.102	4.744	1.578	8.611
Skewness	-0.775	-0.941	-2.733	-1.269	-0.769	-0.634	0.722	0.101	1.593
Min	-0.092	-0.095	-0.138	-0.088	-0.194	-0.135	-0.069	-0.029	-0.060
Max	0.077	0.063	0.071	0.056	0.145	0.100	0.110	0.031	0.140
Count	287	143	287	287	287	287	287	287	287
N	2933	103	14	21	386	411	295	92	81
AUM	3379.6	475.2	22.7	18.3	263.3	325.6	170	60.7	184.6

	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Options Strategies	Others
Mean	0.007	0.005	0.004	0.006	0.006	0.006	0.004	0.006	0.007
Median	0.008	0.006	0.005	0.004	0.006	0.007	0.002	0.006	0.008
Std. dev.	0.021	0.013	0.016	0.016	0.011	0.013	0.023	0.014	0.025
Var	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001
Kurtosis	8.992	45.345	5.239	1.547	13.004	12.322	1.009	6.343	6.522
Skewness	-1.564	-4.907	-0.929	0.667	-1.735	-2.283	0.372	-1.518	1.083
Min	-0.131	-0.136	-0.073	-0.036	-0.078	-0.076	-0.070	-0.073	-0.071
Max	0.063	0.042	0.061	0.075	0.050	0.039	0.098	0.045	0.158
Count	287	287	287	287	287	287	287	227	287
N	22	514	126	45	157	20	64	25	177
AUM	769.8	274.2	179.9	80.8	347.5	285.5	303.6	37.7	71.3

This table exhibits the summary statistics of 18 different hedge fund strategies monthly returns over the sample period of January 1997 until December 2020. The rows under hedge fund strategies represent the average monthly returns for each hedge fund strategy. Penultimate row displays the number of different funds included within the index in question and the final row present the total AUM in billions of USD for each strategy in the end of 3rd quarter of 2020.

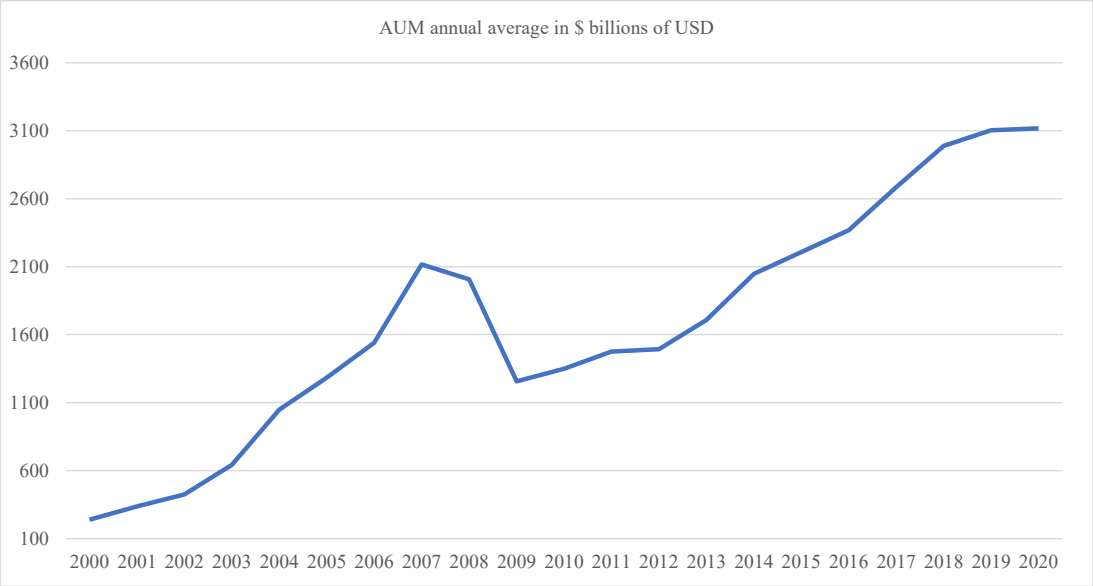

Figure 6. AUM of hedge fund industry.

Figure 6 exhibits the AUM (assets under management) annual average of the hedge fund industry in $ billions USD, according to BarclayHedge. The time sample in this particular figure is between January 2000 and November 2020, since unfortunately the BarclayHedge database does not provide data regarding AUM before the year 2000. The AUM average is calculated from numbers reported quarterly, because only using end-of-year AUM could lead to a downward bias of the valuation. When we analyze figure 6, we can notice a significant drop between 2007 and 2009 which is a clear indicator of a financial crisis during that time period. In particular, the average AUM dropped from $2006,3 billion to $1347,7 billion between 2007 and 2009. In figure 6 we can also study the fact that the growth of AUM has been less abrupt after 2009, indicating the possibility that many funds have gone defunct, have stopped reporting, have gone bankrupt or have been liquidated.

In addition, years 2019 and 2020 show diminishing values in the average AUM, implying the possible effects of the worldwide COVID-19 pandemic. In the year 2020, the total annual average of the entire hedge fund industry is $3116,4 billion whereas in the beginning of the time sample in 2000 it was merely $237,7 billion, giving a great perspective of the growth of AUM in the hedge fund industry.

Table 2. Annualized returns of hedge fund strategies and market.

	Hedge fund strategies																		
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others	Market
1997	0.223		0.157	0.173	0.266	0.227	0.261	0.164	0.268	0.246	0.145	0.177	0.196	0.140	0.172	0.109		0.063	0.312
1998	0.082		0.062	-0.019	-0.274	0.144	0.184	0.106	0.268	0.030	0.008	0.041	0.127	0.096	0.094	0.132		0.185	0.243
1999	0.366		0.139	0.206	0.591	0.430	0.467	0.115	0.424	0.273	0.153	0.269	0.202	0.174	0.216	0.016		0.692	0.252
2000	0.122		0.153	0.053	-0.043	0.037	0.164	0.126	0.207	0.121	0.118	0.102	0.119	0.193	0.217	0.066		0.106	-0.117
2001	0.068		0.166	0.171	0.149	0.055	0.049	0.055	0.046	0.083	0.061	0.044	0.063	0.031	0.105	0.038		-0.018	-0.114
2002	0.014		0.106	0.064	0.051	-0.055	-0.018	0.054	0.015	-0.028	0.071	0.018	0.071	-0.001	0.063	0.137	0.126	-0.079	-0.211
2003	0.180		0.098	0.256	0.354	0.302	0.158	0.041	0.116	0.220	0.100	0.104	0.180	0.084	0.117	0.155	0.128	0.189	0.318
2004	0.088		0.010	0.184	0.150	0.133	0.066	0.038	0.092	0.161	0.071	0.067	0.029	0.052	0.063	0.009	0.070	0.043	0.119
2005	0.107		-0.032	0.079	0.221	0.123	0.115	0.062	0.141	0.082	0.047	0.069	0.094	0.054	0.064	0.028	0.096	0.067	0.061
2006	0.124		0.117	0.147	0.219	0.147	0.080	0.047	0.134	0.156	0.061	0.094	0.078	0.140	0.139	0.056	0.123	0.070	0.154
2007	0.102		0.027	0.069	0.236	0.106	0.079	0.046	0.074	0.084	-0.006	0.089	0.114	0.140	0.096	0.076	0.150	0.072	0.057
2008	-0.216		-0.277	-0.317	-0.395	-0.290	-0.119	-0.011	-0.092	-0.175	-0.252	-0.222	-0.007	-0.034	-0.180	0.136	-0.014	-0.108	-0.367
2009	0.237	0.126	0.536	0.309	0.433	0.294	0.144	-0.004	0.166	0.291	0.198	0.102	0.075	0.117	0.258	-0.048	0.142	0.192	0.283
2010	0.109	0.074	0.122	0.140	0.123	0.142	0.073	0.036	0.069	0.100	0.117	0.049	0.067	0.061	0.108	0.064	0.088	0.111	0.175
2011	-0.055	-0.088	0.001	-0.054	-0.137	-0.090	-0.046	0.002	-0.064	-0.037	0.045	-0.062	-0.037	0.038	-0.023	-0.042	0.050	-0.018	0.005
2012	0.083	0.069	0.087	0.122	0.103	0.094	0.064	0.019	0.097	0.085	0.093	0.047	0.026	0.038	0.058	-0.018	0.049	0.064	0.163
2013	0.111	0.109	0.081	0.168	0.026	0.214	0.139	0.086	0.131	0.108	0.087	0.088	0.048	0.039	0.096	0.008	0.016	0.159	0.352
2014	0.029	0.047	0.012	0.008	-0.017	0.030	0.029	0.046	0.033	0.006	0.053	0.028	0.039	0.007	0.053	0.123	-0.026	0.067	0.117
2015	0.000	-0.002	0.003	-0.101	-0.030	-0.011	0.025	0.052	0.052	-0.032	0.027	-0.001	0.023	0.080	0.011	-0.009	0.071	0.057	0.001
2016	0.061	0.050	0.051	0.144	0.100	0.052	0.018	0.006	-0.041	0.116	0.056	-0.005	0.017	0.064	0.046	-0.044	0.005	0.014	0.135
2017	0.103	0.076	0.026	0.042	0.186	0.140	0.083	0.029	0.083	0.081	0.040	0.060	0.040	0.050	0.059	-0.008	0.077	0.151	0.223
2018	-0.052	-0.060	0.000	0.003	-0.109	-0.088	-0.030	-0.017	-0.031	-0.027	0.004	-0.048	-0.053	0.003	-0.049	-0.046	-0.040	-0.046	-0.051
2019	0.106	0.122	0.084	0.023	0.127	0.153	0.066	-0.006	0.087	0.076	0.024	0.070	0.078	0.064	0.052	0.067	0.126	0.127	0.304
2020	0.074	0.045	0.113	0.098	0.094	0.108	0.056	-0.019	0.018	0.068	0.096	0.066	0.059	0.054	0.020	0.007	0.070	0.166	0.186

Table 2 displays hedge fund strategies annualized equally weighted returns between 1997 and 2020.

Table 2 displays the annualized returns of all 18-hedge fund strategical allocations and market returns from 1997 to 2020. From the table, we can observe that a few funds present particularly volatile returns. The returns of Emerging Markets funds range from -39.55% to + 59.11% of annual returns during the time sample of 1997 – 2020, implying a vast total volatility, a fact also supported by the results found in table 1. Additionally, Market returns, Convertible Arbitrage, Equity Long Bias and Others-categorized strategies also present great amounts of volatility in annual returns. The least fluctuating returns are displayed by Market Neutral funds, and the findings from table 1 showing the standard deviations for this strategy support this fact as well. The highest annualized returns during this time sample are presented by an asset bucket labeled as Others (+69.16%, year 1999) and by the Convertible Arbitrage funds (+53.62%, year 2009). On the other hand, the lowest annualized returns are displayed by the Emerging Markets hedge funds (-39.55%, year 2008 and -27.43%, year 1998) which supports the implications regarding financial crises during these years. The strategies defined as Option- and Balanced Strategies started reporting after the beginning of the time sample in table 2, respectively in 2002 and 2009, hence the blank spaces.

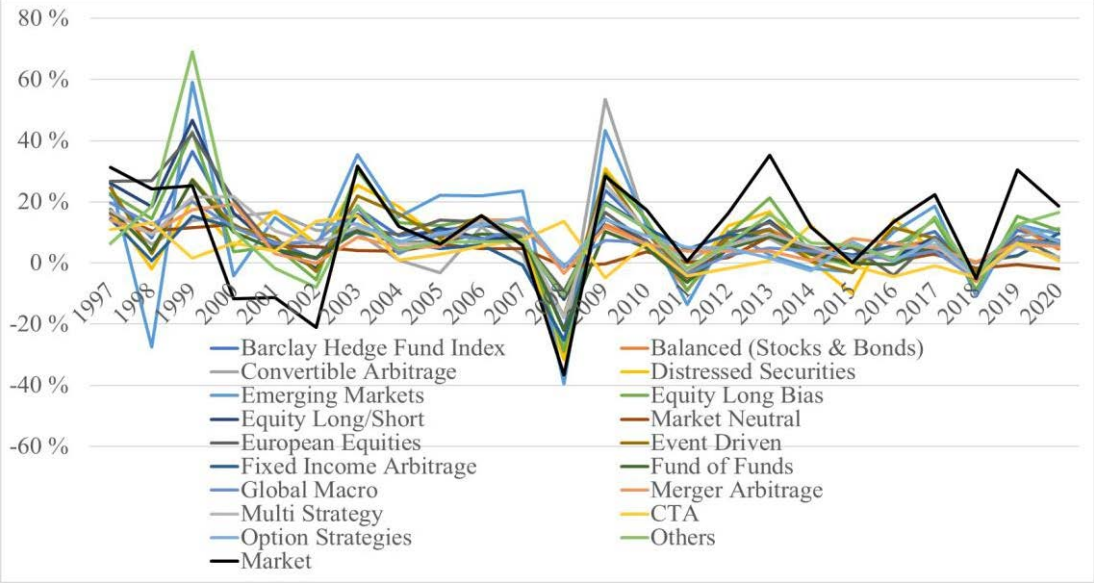

Figure 7. Annual returns of hedge fund strategies and the market.

Figure 7 displays results from table 2 in a simple but informative figure. Annualized hedge fund strategies return data is formatted into a figure, which displays annual

returns as percentages between January 1997 and November 2020. We can see from the figure that previously mentioned Emerging Markets hedge funds have been oscillating a lot during times of financial crises. Fixed income and Convertible arbitrage funds show similar movements which are consistent with the findings presented in table 1. Other hedge fund strategies seem to behave pretty similarly to each other during the time sample of 1997 – 2020 but there are also some clear indications of strategies not following overall market conditions. For instance, investigated from figure 7, CTA hedge funds (yellow line) seem to obtain profits during major financial crises such as in 1999, 2001, and 2008. Similar results, that are not as much affected by the overall market conditions and crises are displayed by Market Neutral and Merger Arbitrage strategies. These results are consistent with the summary statistics provided in table 1. Figure 7 supports well the definitions for crisis periods (1998, 2001, 2008, and 2020), given that the general movement during those periods is for most hedge fund strategies annualized returns to diminish.

5.5 Research Methods

The main objective of this thesis is to analyze the performance of different hedge fund strategies in comparison with market returns during financial crises and during comparison periods. The main findings of this study aim to answer the question of whether some hedge fund strategies perform better than others during crises, since the descriptions of many of strategies claim a better operation during market crises than during tranquillity periods. The performance analysis of hedge fund strategies is conducted during different financial crises affecting hedge funds, such as in 1998, 2001, 2008 and 2020. According to Jiang and Kelly (2012), the most important crisis, described as the LTCM- crisis, starts in August 1998 and ends in December 1998. The second and third crises in 2001 and 2008 are defined by National Bureau of Economic Research (NBER, 2021). The crisis of 2001 starts in March and ends in November of that same year, and the financial crisis of 2008 starts in December 2007 and ends in June 2009. The latest crisis used in this study concerns the global pandemic of COVID-19. According to Ding et al. (2020) the first signs of a market recession begin in December 2019, therefore the time between December 2019 and the end of the time sample in November 2020 is considered as a crisis period.

The comparison period for analyzing hedge fund performance is between 1997 and 2020, excluding the periods of crisis. This period is relatively long timewise in order to capture bearish, average, and bullish market circumstances. As mentioned in chapter 2.6, investors investing in hedge funds try to obtain as much excess alpha as possible. Alpha being a measure of excess return, it is often used as one of the main measures for examining hedge funds performance over market. On the other hand, beta is used in this context to examine how susceptible the investment returns of a hedge fund are against the returns of the whole market. The model used within this study to examine the overall returns of hedge fund strategies compared to the market returns is a single index model, the Capital Asset Prising Model. CAPM was introduced by Sharpe (1964) and Lintner (1965) as follows:

$$R_{h,t} - R_{f,t} = \alpha_i + \beta_i \left(R_{m,t} - R_{f,t}\right) + \varepsilon_{i,t}, \quad (8)$$

Where $R_{h,t}$ portrays pure return on a hedge fund with a particular strategy h, $R_{f,t}$ constitutes as the risk-free return and $R_{m,t}$ represents return on the market on month t which in this study is defined by previously mentioned FF3 Factors (from FF3 excluded SMB and HML). In addition, α_i and β_i represent the intercept of regression as α_i is alpha and β_i is beta, while $\varepsilon_{i,t}$ is the error term on month t. As a proxy for the risk-free rate of returns, this study uses commonly known one-month U.S government T-bill rate, which is also included in the description provided by Fama/French Factors. The CAPM provides an interesting and effective way to determine the risk associated with an investment, as well as the relationship between risks and expected returns. Despite the ideal simplicity of the CAPM model, the empirical problems of the questionable model may negate its application in practice, as the proper functioning of CAPM relies heavily on unrealistic assumptions (Fama & French, 2004). According to Black (1972) the relevance of the CAPM to market risk suits better if risky investments can be sold short, which is the occasion within hedge funds.

The second model used in this study to compare returns of hedge fund strategies and market returns during tranquillity and crisis periods is an augmented version of CAPM with crisis dummy (I_{CR}), and an interaction term between the crisis dummy and the market returns:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i \left(R_{m,t} - R_{f,t}\right) + \rho_i * I_{CR} + \mu_i * \left[\left(R_{m,t} - R_{f,t}\right) * I_{CR}\right] \quad (9)$$

Crisis dummy (I_{CR}) gets a value of 0 during normal market conditions and a value of 1 when markets are facing the various above-mentioned financial crises. One important aspect in this study is examining the correlation coefficients of different hedge fund strategy returns against market returns during different time-periods. Correlation gives a good perspective on the comparability of hedge fund strategies during financial crises and periods of tranquility. As mentioned in chapter 3, many hedge-fund strategies are defined as gaining alpha when markets are facing difficult conditions, therefore one expects the correlation of hedge fund strategy returns and market returns to be low or even negative in multiple situations. According to Patton (2009), Fung and Hsieh (2001), Agarwal and Naik (2002), the low correlation of hedge funds with market returns is one of the oft-cited favorable features of hedge funds. Patton (2009) describes the correlation between the investments and the market as essential since risk-averse investors prefer a low or even negative correlation than a positive correlation.

The hedge fund movements compared to the market ones can be addressed as well by calculating the adjusted R-squared (${R^2}_{adj}$), which should be low in order to support the hypothesis of this study that some hedge funds are doing better than others when market conditions are falling. The adjusted R-squared is used in order to mitigate the possible errors provided by normal R-squared measures, as they tend to get higher when more explanatory variables are introduced in the regression models. According to Titman and Tiu (2011), a low R^2 could be an indicator of managerial success and skill combined with possible signs of market neutrality. In addition to the use of measures such as alpha, beta, R-squared, correlation, kurtosis and skewness, hedge fund returns are evaluated by conducting an analysis of the statistical significance of p-values at a 0.95 confidence level. Even though these calculations can easily be executed and are commonly used, the reliability of the results they provide when evaluating hedge fund- related performance are often vague, due to the dynamic trading strategies of hedge funds and their mysterious way of operating amongst financial markets.

6 EMPIRICAL RESULTS

6.1 Overall benchmarking of hedge funds

This section presents the performance of hedge fund strategies during the overall period from January 1997 until November 2020. Data used within these results are gained from BarclayHedge, and consist of bearish, bullish, and normal market conditions as there are no months of distinctive behavior omitted from the employed sample. Returns of 17 individual hedge fund strategies and one main Barclay Hedge fund index are proxied against market returns provided from the set of FF3 factors (French, 2020). As the FF3 factors normally include other measurements such as SMB (Small Minus Big) and HML (High Minus Low) as well, only estimators for market returns (Rm- Rf) are used from the set of factors. To mitigate the possible consequences of back-filling bias, as suggested by Posthuma et al. (2003), 36 monthly returns are omitted from the scope of this study, as the original data for most of the hedge fund strategies would have begun in 1994.

Table 3 reports the summary statistics of 17 different hedge fund indices, the Barclay Hedge fund index and the market returns established by using monthly returns during the time period from 1997 until 2020. Most sample periods include a total of 287 months, but Option and Balanced (Stocks & Bonds) hedge fund strategies report respectively 227 and 143 months, as the former fund was established in 2002 and the latter in 2009. Surprisingly, the highest average monthly mean among these objects is displayed by Market returns (0.008) and the second highest by the Equity Long Bias (0.0075) hedge fund. The lowest monthly means during this time period are exhibited by CTA hedge funds (0.0035) as well as by Market Neutral hedge funds (0.0036). The standard deviation is upmost in Market returns and Emerging Markets hedge funds while the smallest variation in monthly returns is displayed by Market Neutral hedge funds. A high amount of kurtosis, which indicates the unpredictability of the returns, is indicated within Fixed Income (45.35), - and Convertible Arbitrage (22.66) hedge funds while the lowest kurtosis is indicated within the CTA hedge fund strategies (1.01) and Market returns (1.082). In addition to kurtosis, the lowest skewness (-4.91) is sustained by the Fixed Income Arbitrage hedge fund, showing the returns of this strategy are more negative than positive.

Table 3. Summary statistics of hedge fund strategies and market returns during overall period.

Hedge Fund strategies and Market

	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities
Mean	0.007	0.004	0.006	0.006	0.007	0.008	0.007	0.004	0.007
Median	0.007	0.005	0.006	0.009	0.011	0.009	0.006	0.004	0.007
Std. dev.	0.021	0.019	0.017	0.020	0.039	0.033	0.020	0.009	0.022
Var	0.000	0.000	0.000	0.000	0.002	0.001	0.000	0.000	0.001
Kurtosis	4.127	5.064	22.658	3.880	3.801	2.102	4.744	1.578	8.611
Skewness	-0.775	-0.941	-2.733	-1.269	-0.769	-0.634	0.722	0.101	1.593
Min	-0.092	-0.095	-0.138	-0.088	-0.194	-0.135	-0.069	-0.029	-0.060
Max	0.077	0.063	0.071	0.056	0.145	0.100	0.110	0.031	0.140
Count	287	143	287	287	287	287	287	287	287

	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Options Strategies	Others	Market
Mean	0.007	0.005	0.004	0.006	0.006	0.006	0.004	0.006	0.007	0.008
Median	0.008	0.006	0.005	0.004	0.006	0.007	0.002	0.006	0.008	0.014
Std. dev.	0.021	0.013	0.016	0.016	0.011	0.013	0.023	0.014	0.025	0.046
Var	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.002
Kurtosis	8.992	45.345	5.239	1.547	13.004	12.322	1.009	6.343	6.522	1.082
Skewness	-1.564	-4.907	-0.929	0.667	-1.735	-2.283	0.372	-1.518	1.083	-0.604
Min	-0.131	-0.136	-0.073	-0.036	-0.078	-0.076	-0.070	-0.073	-0.071	-0.172
Max	0.063	0.042	0.061	0.075	0.050	0.039	0.098	0.045	0.158	0.137
Count	287	287	287	287	287	287	287	227	287	287

This table exhibits the summary statistics of hedge fund strategies monthly returns over the sample period of January 1997 until December 2020. The rows under hedge fund strategies represent the average monthly returns for each hedge fund strategy. The penultimate row displays the number of total months of reported activity among hedge fund strategies as reported by BarclayHedge.

6.1.1 Alpha during overall time periods

Table 4 displays the monthly alphas of the hedge fund strategies over the market returns during the period from 1997 until 2020. The alpha estimates are calculated by utilizing CAPM as a standard OLS with time series regression, as explained in equation 8. If a hedge fund strategy obtains positive alpha values according to table 4, it has outperformed the market returns. In addition, if these alpha p-values are not statistically significant (p-value > 0.05), it indicates that even though alpha might be greater compared to the market returns, it is not statistically significant. The lowest and only negative alpha values are displayed by the Balanced- hedge fund strategy, but these results are statistically insignificant with the 0.95 confidence level. As these results might be biased due to this strategy being established later than 1997, as in 2009, when omitting Balanced hedge fund strategy, the worst alphas over market returns are generated by Fund of Funds and Market Neutral hedge funds. Taking into consideration the possibility that returns increase according to possible additions in risks, according to table 3, the Market Neutral hedge funds seem to have less volatility in returns, which also explains the possible low alpha generated in table 4. The highest excess return over market returns (alpha) is produced by European Equities and Option strategies hedge funds. However, as explained in chapter 5.2, hedge funds are prone towards several biases, which might alter the reliability of the results exhibited above.

Table 4. Hedge fund alpha of monthly returns.

	Hedge fund strategies								
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities
Alpha	0.003	-0.001	0.003	0.003	0.001	0.002	0.003	0.002	0.004
P-value	0.000	0.193	0.001	0.005	0.387	0.038	0.000	0.000	0.000
	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others
Alpha	0.003	0.002	0.001	0.003	0.003	0.003	0.002	0.004	0.003
P-value	0.000	0.003	0.220	0.001	0.000	0.000	0.109	0.000	0.002

This table presents the average monthly alphas of different hedge fund strategies during whole sample period as well as the p-value for the alpha. Alpha is calculated by utilizing CAPM as defined in equation 8.

6.1.2 Beta coefficient and correlation during overall period

Table 5 presents the results concerning the neutrality of different hedge fund strategies during the overall time period from 1997 until 2020. Measurements such as Beta coefficient estimates, R-squared a correlation are obtained by using CAPM through OLS regression. These factors measure the relationship of hedge fund strategies against market returns during bullish, bearish, and normal market conditions. Lower beta values indicate that the returns of these particular hedge fund strategies are not highly correlated with market returns during this time period, whereas negative Beta values would indicate the sensitiveness between market returns and hedge fund strategies as being opposite. P-values display answers as to whether the results are statistically significant at 0.95 confidence level (P-value < 0.05). In addition to these factors, the adjusted R-squared results are also presented in table 6, which should support the findings made when evaluating the beta-coefficients.

All hedge fund strategies except for CTAs seem to obtain statistically significant p-values at a 0.95 confidence level during the time period from 1997 to 2020. The negative coefficient beta of CTA hedge funds implies that the returns of this hedge fund have been moving in the opposite direction when compared against market returns. The highest beta value is obtained in this case by Equity Long Bias- hedge funds (0.65) and by Emerging Markets (0.61), which is consistent with the investment practices of these hedge funds, as explained in chapter 4. Adjusted R-square measures the neutrality of variables as well. According to Titman and Tiu (2001), low levels of adjusted R-squared suggest a market neutrality combined with managerial skills. The lowest amounts of adjusted R-squared are exhibited by the CTA (0.003) and the Market Neutral (0.045) hedge funds, while the uppermost degrees are displayed by the Equity Long Bias (0.833) and the Balanced (0.741) hedge funds.

Table 5. Hedge funds neutrality measures during overall time period.

	Hedge fund strategies								
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities
Beta	0.375	0.370	0.178	0.272	0.610	0.650	0.328	0.039	0.273
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Adj. R^2	0.712	0.741	0.230	0.385	0.517	0.833	0.591	0.045	0.322

	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others
Beta	0.340	0.115	0.236	0.184	0.139	0.175	-0.041	0.132	0.390
P-value	0.000	0.000	0.000	0.000	0.000	0.000	0.159	0.000	0.000
Adj. R^2	0.591	0.156	0.499	0.283	0.342	0.380	0.003	0.161	0.538

This table presents the coefficient beta, p-value of beta, and adjusted R-squared measures for different hedge fund strategies during the overall time period between January 1997 and November 2020. These measures are obtained by utilizing CAPM.

Table 6 displays the correlation coefficient between different hedge fund strategies and market returns during the overall time period. P-value of correlation measures whether the results are statistically significant at a 0.95 confidence level or not. All strategies except for CTA hedge funds present statistically significant P-values with a 0.95 confidence level, which is also consistent with the previous findings. The uppermost level of correlation is indicated by Equity Long Bias- hedge fund indices (0.91) and Balanced hedge funds (0.86), which is also consistent with the findings made regarding R-squared measures in table 6. On the other hand, the minimal correlation (when excluding CTA hedge funds) is shown by Market Neutral hedge funds, which is also consistent with the other findings presented in this chapter.

Table 6. Correlation of hedge funds and market returns.

	Hedge Fund Strategies								
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities
Correlation	0.839	0.862	0.478	0.619	0.719	0.912	0.762	0.207	0.565
P-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others
Correlation	0.765	0.392	0.698	0.527	0.572	0.606	-0.085	0.399	0.732
P-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.149	0.000	0.000

This table presents the correlation and p-value of correlation between market returns and hedge fund strategies amongst 1997 and 2020.

6.2 Benchmarking Hedge Funds during the financial crises

This section presents the performance of hedge fund strategies during the financial crisis periods of 1998, 2001, 2008 and 2020. The first crisis, or LTCM- crisis took place between 08/1998 and 12/1998 (Jiang and Kelly, 2012), and the following one occurred between 03/2001 and 11/2001 (NBER, 2021). The following financial crisis was the longest, lasting from 12/2007 to 06/2009 (NBER, 2021). The latest crisis included in the dataset was triggered by the COVID-19 pandemic and occurred between 12/2019 and 11/2020 (Ding et al. 2019). Therefore, the maximum number of months in the data sample during the different financial crises is 47. The returns of 17 individual hedge fund strategies and of the Barclay Hedge fund index are proxied against the market returns provided according to FF3 factors (French, 2020). The original data for most of the hedge fund strategies begins in 1994 but in order to mitigate the possible consequences of a back-filling bias, the 36 first monthly returns are omitted from the scope of this study, as suggested by Posthuma et al. (2003).

Table 7 displays the summary statistics of the monthly returns on 17 different hedge fund indices, on the Barclay Hedge fund index and the return on the market during several financial crises. Most sample periods include the total of 47 comparative crisis

months, but Option and Balanced (Stocks & Bonds) hedge fund strategies report 31 and 18 months due to these funds being established in 2002 and 2009. The average monthly return of the market during this combined crisis period a negative -0.1 %, implying that the overall market returns have been falling. During these financial crises, Distressed securities (-0.4%), Fixed Income Arbitrage (-0.3%), Fund of Funds (-0.3%) and Emerging Markets (-0.5%) present negative monthly average returns. Surprisingly, the rest of the hedge fund strategies in question are able to generate profits despite falling market conditions. The most average monthly means are generated by the Option Strategies (+0.6%), Others (+0.6%), CTA (+0.5%), and Balanced (+0.5%) funds.

From table 7, we can observe some interesting implications about standard deviation, since Market returns have the highest standard deviation of all the hedge fund strategies in the data sample. Another interesting finding is that Market Neutral hedge funds present the lowest standard deviation while the Emerging Markets hedge funds display a high amount of standard deviation even during financial crises, which is consistent with the findings presented in table 1. The highest kurtosis is presented by Fixed Income Arbitrage- hedge funds, and the lowest by market returns. In addition, the skewness is also the most negative amongst the Fixed Income Arbitrage funds, suggesting that relatively most share of returns displayed are negative. Even though all the skewness factors presented in table 7 are negative, the lowest amount of negative skewness is displayed by Global Macro- hedge fund strategies.

Table 7. Summary statistics of hedge funds and market monthly returns during financial crises.

Hedge fund strategies

	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities
Mean	0.001	0.005	0.003	-0.004	-0.005	0.000	0.002	0.002	0.001
Median	0.004	0.008	0.008	0.002	0.003	0.005	0.004	0.003	0.003
Std. dev.	0.033	0.037	0.034	0.033	0.062	0.052	0.026	0.012	0.023
Var	0.001	0.001	0.001	0.001	0.004	0.003	0.001	0.000	0.001
Kurtosis	1.331	2.268	6.423	0.634	1.393	0.454	0.754	0.257	0.313
Skewness	-0.975	-0.972	-2.082	-0.798	-0.900	-0.692	-0.689	-0.097	-0.500
Min	-0.092	-0.095	-0.138	-0.088	-0.194	-0.135	-0.069	-0.029	-0.060
Max	0.058	0.063	0.057	0.056	0.111	0.100	0.046	0.029	0.047
Count	47	18	47	47	47	47	47	47	47

	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others	Market
Mean	0.001	-0.003	-0.003	0.004	0.003	0.001	0.005	0.006	0.006	-0.001
Median	0.007	0.004	0.002	0.004	0.007	0.005	0.002	0.012	0.012	0.004
Std. dev.	0.035	0.027	0.025	0.017	0.021	0.024	0.025	0.021	0.031	0.073
Var	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.001	0.005
Kurtosis	4.500	12.335	1.873	-0.109	4.931	4.051	0.935	6.227	-0.163	-0.424
Skewness	-1.515	-2.982	-1.264	-0.046	-1.375	-1.792	-0.137	-2.252	-0.192	-0.351
Min	-0.131	-0.136	-0.073	-0.033	-0.078	-0.076	-0.070	-0.073	-0.071	-0.172
Max	0.063	0.026	0.039	0.038	0.050	0.039	0.055	0.030	0.073	0.137
Count	47	47	47	47	47	47	47	31	47	47

This table exhibits the summary statistics of hedge fund strategies monthly returns over the sample period of January 1997 until December 2020 during several financial (1998, 2001, 2008, and 2020) crises all merged into one data sample. The rows under hedge fund strategies represent the average monthly returns for each hedge fund strategy. The penultimate row displays the number of total months of financial crises concerning particular hedge fund strategies as reported by BarclayHedge.

6.2.1 Annualized hedge fund and market returns during financial crises

Table 8. Annualized hedge fund and market returns during different financial crises.

Hedge fund strategies and Market

	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities
1998	0.015		0.008	-0.088	-0.205	0.044	0.067	0.052	-0.005
2001	0.034		0.098	0.107	0.059	0.011	0.018	0.051	0.031
2008	-0.126	0.024	-0.098	-0.253	-0.253	-0.199	-0.056	-0.011	-0.025
2020	0.092	0.059	0.120	0.095	0.133	0.126	0.075	-0.020	0.045
Annualized	0.000	0.021	0.028	-0.047	-0.081	-0.012	0.025	0.018	0.011

	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others	Market
1998	-0.047	-0.031	-0.023	0.062	0.043	0.019	0.126		0.108	0.111
2001	0.033	0.043	0.016	0.052	0.009	0.054	0.010		0.003	-0.070
2008	-0.064	-0.219	-0.186	0.026	0.024	-0.069	0.098	0.100	-0.009	-0.341
2020	0.085	0.102	0.079	0.067	0.061	0.031	0.003	0.073	0.182	0.221
Annualized	0.000	-0.034	-0.034	0.052	0.034	0.008	0.058	0.042	0.068	-0.045

This table presents annualized average equal-weighted monthly returns for each hedge fund strategy and the market returns, which in this case are defined by FF3 factors. Annualized returns are presented of financial crises in 1998, 2001, 2008, and 2020. Annualized returns are calculated separately for different financial crises along with the whole combined financial crisis period in the row "Annualized".

Table 8 presents the equal-weighted annualized returns of different hedge fund strategies and the market returns during several financial crises as a combined whole entity labelled as "Annualized". The results provided from this table give a good perspective of the entire movement experienced by the hedge fund strategies as well as by the entire market returns. Consistent with the previous calculations, the returns of the Emerging Markets hedge fund strategies have been worst during times of market turmoil. In particular, the annualized returns of the combined financial crises show a negative -8.1%, as calculated from the entire crisis- data sample of 47 months. Other major overall losses are presented by Distressed securities hedge funds (-4.7%) and by the overall Market returns (-4.5%). Distinctively terrible losses are experienced by the overall market returns during the crises of 2001 (-7.0%) and 2008 (-34.1%). However, many of the funds are still able to present positive returns, even during the times of financial crises. The utmost superior returns during the combined annualized period

are displayed by the Others (+6.8%), CTA´s (+5.8%) and Global Macro (+5.2%) hedge funds. Findings from table 8 seem to support the fact that some hedge fund strategies do not follow market returns unconditionally and are able to create prosperous gains for investors investing in hedge funds. Yet again, it is good to keep in mind that these results might be biased upwards due to hedge funds tendency to include several data related biases. In addition to excess returns, some hedge fund strategies have generated more losses than the Market returns during these financial crisis periods. For instance, investing in hedge fund indices following Distressed Securities, - or Emerging Markets -strategies would have resulted in increased losses during several financial crises. Findings in table 8 about the Distressed Securities hedge fund are not aligned with its description, since Chambers et al. (2018, p. 33) define this strategy as successful in situations when the markets are facing turmoil and downturns.

6.2.2 Alpha during financial crises

Table 9 displays hedge fund alphas of monthly returns during financial crisis periods. The alpha estimates are calculated by utilizing an augmented version of the CAPM as explained in equation 9, in which the alphas represent the distinction between alpha values in several crisis periods and normal market conditions. Therefore, if a hedge fund strategy obtains positive alpha values in table 9, it has outperformed alphas during normal time periods. In addition, if these crisis alpha p-values are not statistically significant (p-value > 0.05), it indicates that even though alpha might be greater during financial crisis periods than in normal market conditions, the difference between the alphas is not statistically significant.

We can analyze from table 9 that the most positive alpha over non-crisis returns during several financial crisis periods is presented by Option Strategies- hedge funds with a statistically insignificant p-value. The other positive alpha values listed in table 9 all include statistically insignificant p-values, indicating the reality, that even if alpha values are greater during financial crises than in normal market conditions, it is statistically not significant. On the other hand, the negative alphas displayed for instance by Distressed Securities, Fixed Income Arbitrage, and Fund of Funds- hedge fund strategies are statistically significant and negative during financial crises periods.

Table 9. Hedge fund alpha of monthly returns during financial crisis.

	Hedge fund strategies								
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities
Alpha	0.000	-0.002	0.002	-0.004	-0.005	0.001	0.002	0.000	0.000
P-Value	0.076	0.625	0.508	0.001	0.063	0.501	0.461	0.127	0.147
	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others
Alpha	0.000	-0.004	-0.004	0.003	0.002	0.000	0.003	0.006	0.006
P-Value	0.080	0.000	0.002	0.666	0.194	0.009	0.671	0.402	0.266

This table presents the average monthly alphas of different hedge fund strategies during combined financial crisis periods. Alpha is calculated by utilizing an augmented version of CAPM as defined in equation 9.

The findings presented in table 9 seem to be in opposition to the overall perception of the performance of hedge funds during periods of financial crisis. Gao et al. (2018) state that hedge funds are able to benefit from disastrous market conditions rather than be harshly exposed to market risks and overall conditions of the market. This assumption does not seem to apply.

Table 10 presents the results concerning the neutrality of different hedge fund strategies during periods of financial crisis by investing measurements such as beta estimates, R-squared and correlation. These measurements are obtained by using the augmented version of CAPM, as explained in equation 9 and they measure the relationship of hedge fund strategies against market returns during times of financial crises (1998, 2001, 2008 and 2020) and in normal market conditions. The values established from the section “Crisis Beta” represent the difference in beta values during normal market conditions and during crisis periods. The lower beta values indicate that the returns of hedge fund strategies are not highly correlated with the market returns during periods of financial crisis, whereas the negative Beta values would indicate a sensitiveness between the market returns and hedge fund strategies as opposite. The crisis Beta P-values display answers about whether the results are statistically significant at a 0.95 confidence level (P-value < 0.05). In addition to these

factors, the adjusted R-squared results are also presented in table 10, which should support the findings made when evaluating beta-coefficients.

The hedge-fund strategies with statistically significant Beta values are: Convertible Arbitrage-, Market Neutral-, Event Driven-, Fixed Income Arbitrage-, Global Macro-, Merger Arbitrage-, Multi Strategy-, Barclay Hege Fund Index and CTA- funds. Among these strategies, the highest Crisis- Beta value is displayed by the overall fund, Barclay Hedge Fund Index, with a beta value of 0.41. This result is logical since this particular fund consists of different funds using distinctive investing strategies. If this fund is excluded from the dataset, the highest beta-value is presented by Event Driven-hedge funds with a beta value of 0.38. Table 10 also presents one hedge-fund strategy, the CTA, with a statistically significant negative beta value of -0.12. The negative beta value of CTA hedge fund strategies suggests that the returns of this strategy move in different directions when compared to market returns, implicating that when markets are negative, this strategy is able to gain positive returns. These results are also supported by the findings regarding R-squared measures, since CTA hedge funds have the lowest level of 0.013, whereas the highest R-squared levels are displayed by the hedge fund strategy Equity Long Bias (0.833).

Table 10. Hedge funds neutrality measures during financial crises.

	Hedge fund strategies								
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities
Beta	0.407	0.416	0.267	0.297	0.674	0.675	0.314	0.008	0.236
P-value	0.046	0.054	0.000	0.196	0.096	0.220	0.507	0.016	0.238
Adj. R^2	0.591	0.745	0.266	0.408	0.524	0.833	0.589	0.066	0.326
	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others
Beta	0.382	0.158	0.252	0.135	0.222	0.220	-0.116	0.157	0.393
P-value	0.027	0.009	0.242	0.019	0.000	0.002	0.033	0.356	0.989
Adj. R^2	0.591	0.212	0.514	0.292	0.424	0.410	0.013	0.160	0.537

This table presents the coefficient beta, p-value of beta, and adjusted R-squared measures for different hedge fund strategies during several combined financial crises included in the time sample between 1997 and 2020. These measures are obtained by using the augmented version of CAPM, as described in equation 9.

Table 11 displays the correlation coefficient between different hedge-fund strategies and market returns during the above-mentioned financial crises. The P-value of correlation measures whether the results are statistically significant. All strategies, except for Market Neutral hedge funds present statistically significant P-values with a 0.95 confidence level. The uppermost level of correlation is indicated by Equity Long Bias- hedge fund indices (0.95), which is also consistent with the findings made regarding R-squared measures in table 5. In addition to this, CTA hedge funds present a negative correlation of -0.35, which suggests that this strategy is highly uncorrelated with the returns exhibited by market returns during financial crises. These results are consistent with the findings presented by Chambers et al. (2018, p. 37), as they define that CTA strategies have tendencies of low correlation against market returns.

Table 11. Correlation during financial crises.

	Hedge fund strategies								
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/ Short	Market Neutral	European Equities
Correlation	0.887	0.893	0.563	0.650	0.796	0.947	0.891	0.038	0.728
P-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.797	0.000
	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others
Correlation	0.793	0.423	0.744	0.563	0.772	0.658	-0.346	0.554	0.916
P-Value	0.000	0.003	0.000	0.000	0.000	0.000	0.017	0.000	0.000

This table presents the correlation and p-value of correlation between market returns and hedge fund strategies amongst several financial crises between 1997 and 2020.

6.3 Benchmarking of hedge funds during the comparison period

The comparison period includes the same data used for calculating the previously presented results during several financial crises between January 1997 and November 2020, with the exception that all the periods of financial crises are omitted from the data sample. The cumulated total of months without financial crisis periods during this time sample is 240. Table 13 presents the summary statistics of the monthly returns on hedge fund strategies during the comparison period between 1997 and 2020. Balanced

(Stocks & Bonds) hedge fund strategy only has 125 months in this set and Option Strategies only 196, since they were introduced later in this data sample.

Table 12. Summary statistics of hedge fund strategies returns during the comparison period.

	Hedge fund strategies									
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities	
Mean	0.008	0.004	0.006	0.008	0.010	0.009	0.008	0.004	0.009	
Median	0.008	0.005	0.006	0.009	0.011	0.010	0.006	0.004	0.007	
Std. dev.	0.017	0.015	0.011	0.016	0.033	0.028	0.019	0.008	0.022	
Var	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	
Kurtosis	1.541	0.579	5.675	1.087	1.569	0.321	6.128	1.713	10.348	
Skewness	0.283	-0.608	0.762	-0.573	0.082	-0.049	1.516	0.409	2.130	
Min	-0.043	-0.042	-0.034	-0.052	-0.102	-0.067	-0.034	-0.022	-0.043	
Max	0.077	0.040	0.071	0.055	0.145	0.094	0.110	0.031	0.140	
Count	240	125	240	240	240	240	240	240	240	
	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others	Market
Mean	0.008	0.006	0.005	0.006	0.006	0.007	0.003	0.006	0.008	0.010
Median	0.008	0.006	0.006	0.004	0.006	0.008	0.003	0.006	0.008	0.014
Std. dev.	0.016	0.008	0.013	0.016	0.008	0.010	0.023	0.013	0.023	0.039
Var	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.002
Kurtosis	0.426	4.970	2.174	1.953	0.663	0.433	1.105	4.743	9.686	0.238
Skewness	-0.191	-0.173	0.432	0.849	-0.190	-0.256	0.491	-1.000	1.657	-0.418
Min	-0.037	-0.033	-0.028	-0.036	-0.019	-0.020	-0.058	-0.063	-0.052	-0.102
Max	0.062	0.042	0.061	0.075	0.030	0.035	0.098	0.045	0.158	0.114
Count	240	240	240	240	240	240	240	196	240	240

This table exhibits the summary statistics of hedge fund strategies monthly returns over the sample period of January 1997 until December 2020 several financial crises omitted (1998, 2001, 2008, and 2020) from the time sample. The rows under hedge fund strategies represent the average monthly returns for each hedge fund strategy. The penultimate row displays the number of total months of comparison period concerning particular hedge fund strategies as reported by BarclayHedge.

From table 12 we can perceive that during the comparison period from which all financial crises are excluded, the hedge fund indices only present positive returns. Surprisingly, the highest levels of mean are presented by Market returns (0.01 monthly), Emerging Markets (0.01) and Equity Long bias hedge funds (0.009). The lowest average mean is experienced by the CTA hedge funds, which is consistent with the findings regarding CTA´s profound success during periods of financial crisis. The highest standard deviation of average returns is exhibited by Market returns, and lowest by the Market Neutral hedge funds. On the other hand, the highest amounts of kurtosis and skewness are experienced by the European Equities hedge funds. The lowest level of kurtosis is also experienced by Market returns, indicating that extreme returns on both ends have been lowest.

Table 13 presents the annualized monthly returns calculated as equal-weighted during the comparison period from January 1997 to November 2020, excluding the months of financial crises. Obviously, these results are upward biased towards higher returns simply due to the fact that the months of financial crises are omitted from the data sample, in order to capture differentiated results than those gained when only observing the months of financial crises. The highest annualized average returns in this sample are presented by the hedge fund strategies “Others” in 1999 (+69.2%) while the lowest returns are experienced by Market- returns in 2001 (-21.1%). These results might be biased due to this year having fewer observable months after omitting the financial crisis periods. When entirely omitting the years 1998, 2001, 2008 and 2020, the lowest returns (-13.7%) are experienced in 2011 by the Emerging Markets hedge fund strategies.

Table 13. Hedge fund strategies and market return during the comparison period.

	Hedge fund strategies																	
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others	Market
1997	0.223		0.157	0.173	0.266	0.227	0.261	0.164	0.268	0.246	0.145	0.177	0.196	0.140	0.172	0.109		0.063	0.312
1998	0.066		0.054	0.076	-0.087	0.095	0.110	0.051	0.274	0.081	0.040	0.065	0.061	0.051	0.073	0.005		0.069	0.119
1999	0.366		0.139	0.206	0.591	0.430	0.467	0.115	0.424	0.273	0.153	0.269	0.202	0.174	0.216	0.016		0.692	0.252
2000	0.122		0.153	0.053	-0.043	0.037	0.164	0.126	0.207	0.121	0.118	0.102	0.119	0.193	0.217	0.066		0.106	-0.117
2001	0.033		0.062	0.057	0.085	0.044	0.031	0.004	0.014	0.049	0.017	0.028	0.010	0.022	0.049	0.028		-0.021	-0.047
2002	0.014		0.106	0.064	0.051	-0.055	-0.018	0.054	0.015	-0.028	0.071	0.018	0.071	-0.001	0.063	0.137	0.126	-0.079	-0.211
2003	0.180		0.098	0.256	0.354	0.302	0.158	0.041	0.116	0.220	0.100	0.104	0.180	0.084	0.117	0.155	0.128	0.189	0.318
2004	0.088		0.010	0.184	0.150	0.133	0.066	0.038	0.092	0.161	0.071	0.067	0.029	0.052	0.063	0.009	0.070	0.043	0.119
2005	0.107		-0.032	0.079	0.221	0.123	0.115	0.062	0.141	0.082	0.047	0.069	0.094	0.054	0.064	0.028	0.096	0.067	0.061
2006	0.124		0.117	0.147	0.219	0.147	0.080	0.047	0.134	0.156	0.061	0.094	0.078	0.140	0.139	0.056	0.123	0.070	0.154
2007	0.097		0.041	0.080	0.215	0.102	0.076	0.040	0.070	0.085	-0.004	0.085	0.099	0.138	0.093	0.068	0.126	0.071	0.063
2009	0.115	0.099	0.214	0.186	0.179	0.151	0.072	0.002	0.090	0.136	0.146	0.058	0.055	0.056	0.111	-0.008	0.045	0.073	0.224
2010	0.109	0.074	0.122	0.140	0.123	0.142	0.073	0.036	0.069	0.100	0.117	0.049	0.067	0.061	0.108	0.064	0.088	0.111	0.175
2011	-0.055	-0.088	0.001	-0.054	-0.137	-0.090	-0.046	0.002	-0.064	-0.037	0.045	-0.062	-0.037	0.038	-0.023	-0.042	0.050	-0.018	0.005
2012	0.083	0.069	0.087	0.122	0.103	0.094	0.064	0.019	0.097	0.085	0.093	0.047	0.026	0.038	0.058	-0.018	0.049	0.064	0.163
2013	0.111	0.109	0.081	0.168	0.026	0.214	0.139	0.086	0.131	0.108	0.087	0.088	0.048	0.039	0.096	0.008	0.016	0.159	0.352
2014	0.029	0.047	0.012	0.008	-0.017	0.030	0.029	0.046	0.033	0.006	0.053	0.028	0.039	0.007	0.053	0.123	-0.026	0.067	0.117
2015	0.000	-0.002	0.003	-0.101	-0.030	-0.011	0.025	0.052	0.052	-0.032	0.027	-0.001	0.023	0.080	0.011	-0.009	0.071	0.057	0.001
2016	0.061	0.050	0.051	0.144	0.100	0.052	0.018	0.006	-0.041	0.116	0.056	-0.005	0.017	0.064	0.046	-0.044	0.005	0.014	0.135
2017	0.103	0.076	0.026	0.042	0.186	0.140	0.083	0.029	0.083	0.081	0.040	0.060	0.040	0.050	0.059	-0.008	0.077	0.151	0.223
2018	-0.052	-0.060	0.000	0.003	-0.109	-0.088	-0.030	-0.017	-0.031	-0.027	0.004	-0.048	-0.053	0.003	-0.049	-0.046	-0.040	-0.046	-0.051
2019	0.088	0.107	0.077	0.025	0.088	0.135	0.046	-0.005	0.059	0.059	0.019	0.057	0.069	0.056	0.041	0.071	0.122	0.111	0.267

This table presents equal-weighted annualized monthly returns of hedge fund strategies and the market during the comparison period from 1997 to 2020.

6.3.1 Alpha during comparison period

Table 14 presents the monthly alphas of hedge fund strategies over market returns during the comparison period. The alpha estimates are calculated by utilizing an augmented version of the CAPM, as explained in equation 9, in which the alphas represent the difference between alpha values in several crisis periods and normal market conditions. Hence, if a hedge fund strategy obtains positive alpha values in table 14, it represents the overall outperformance during this time period. In addition, if these crisis alpha p-values are not statistically significant (p-value < 0.05), it indicates that even though alpha might be positive during the comparison period, it is not statistically significant.

The results from table 14 indicate that almost all hedge fund alphas are positive and statistically significant on a 0.95 confidence level, except for the Balanced (Stocks & Bonds) funds. However, due to several hedge funds related biases, on some extent these results might be faulty. The highest monthly return over market (alpha) during the comparison period is generated by the hedge funds following the European Equities investing strategies, while the worst positive excess returns are generated by CTA and Market Neutral Hedge fund strategies. These results are consistent with the ones measured during financial crises, as these funds presented the most positive characteristics of returns then as well.

Table 14. Hedge fund alpha of monthly returns during comparison period.

	Hedge fund strategies								
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities
Alpha	0.003	-0.001	0.004	0.004	0.003	0.002	0.003	0.002	0.005
P-value	0.000	0.405	0.000	0.000	0.079	0.022	0.000	0.000	0.000
	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others
Alpha	0.004	0.004	0.002	0.002	0.004	0.004	0.002	0.003	0.003
P-value	0.000	0.000	0.011	0.013	0.000	0.000	0.313	0.001	0.020

This table presents the average monthly alphas of different hedge fund strategies during the combined comparison period. Alpha is calculated by utilizing an augmented version of CAPM as defined in equation 9.

6.3.2 Beta coefficient and correlation during comparison period

Table 15 indicates that hedge funds reach neutral results against market returns during the comparison period. These measurements are obtained by using the augmented version of CAPM, as explained in equation 9. As the months of financial crises are omitted from this dataset, these factors measure the relationship of hedge fund strategies against market returns during normal and bullish market conditions. Beta values established from this section represent the sensitiveness of hedge-fund strategy returns against market returns and P-value displays results as to whether they are statistically significant at a 0.95 confidence level (P-value < 0.05).

According to table 15, all hedge fund strategies except for CTAs have statistically significant Beta values at a 0.95 confidence level. The CTA- hedge funds actually hold the lowest value for Beta coefficient (0.011) and it is not significantly different from zero (P-value = 0.766) statistically, meaning that this strategy is especially neutral to market returns during the comparison period. When omitting CTA hedge funds from this sample, the lowest Beta value is displayed by Market Neutral hedge funds, which is consistent with the description regarding the investment practices of this hedge fund. On the other hand, the hedge fund strategy following Equity Long Bias investment practices has the Beta coefficient of (0.631), indicating that this strategy is very sensitive to the movements experienced by market returns.

Table 15. Hedge funds Beta during comparison period.

	Hedge fund strategies								
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities
Beta	0.350	0.343	0.116	0.244	0.556	0.631	0.336	0.058	0.292
P-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others
Beta	0.307	0.076	0.219	0.218	0.081	0.138	0.011	0.119	0.392
P-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.766	0.000	0.000

This table presents the coefficient beta and p-value of beta hedge fund strategies during the combined comparison period included in the time sample between 1997 and 2020. These measures are obtained by using the augmented version of CAPM, as described in equation 9.

When comparing the results presented in table 15 with the ones shown in table number 10, we can notice that several funds such as Equity Long/Short, Market Neutral, Global Macro and CTA funds present higher beta value estimates during comparison period. This would indicate that these funds are not highly correlated with market returns.

Table 16 displays the correlation-coefficient between the different hedge fund strategies and the market returns during the combined comparison periods between 1997 and 2020. The P-value of correlation measures whether the results are statistically significant at a 0.95 confidence level. All the strategies except for the CTA hedge funds present statistically significant P-values with a 0.95 confidence level. The uppermost level of correlation is indicated by Equity Long Bias- hedge fund indices (0.89), as it is similar during financial crisis periods, as displayed in table 10. Significant correlation is also indicated by many other hedge fund strategies, including Balanced, the entire Barclay Hedge Fund Index, Event Driven and Equity Long/Short hedge funds. A negative correlation (-0.085) is again exhibited by CTA hedge funds with statistically insignificant p-values, indicating a true neutrality of this strategy against market returns. When omitting CTA strategies, Market Neutral hedge funds obtain the second to lowest level of correlation, which is consistent with the findings presented in table 15 regarding Beta-values.

Table 16. Correlation during comparison period

	Hedge fund strategies								
	Barclay Hedge Fund Index	Balanced	Convertible Arbitrage	Distressed Securities	Emerging Markets	Equity Long Bias	Equity Long/Short	Market Neutral	European Equities
Correlation	0.803	0.843	0.408	0.591	0.663	0.887	0.707	0.287	0.522
P-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Event Driven	Fixed Income Arbitrage	Fund of Funds	Global Macro	Merger Arbitrage	Multi Strategy	CTA	Option Strategies	Others
Correlation	0.743	0.374	0.664	0.535	0.393	0.563	0.017	0.330	0.658
P-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.792	0.000	0.000

This table presents the correlation and p-value of correlation between market returns and hedge fund strategies amongst comparison period between 1997 and 2020.

CONCLUSIONS

One particularly attractive reason for considering investing in hedge funds is their described ability to obtain different levels and types of risks through various exposures to distinct markets companied with unlike betas and alphas. Hence, one of the main attractions of hedge funds is their feature of low vulnerability towards market risk. The financial crisis of 2008 showed the markets that hedge funds might not include so little market risk as it is perceived. According to Billio et al. (2010), all hedge fund strategies performed dreadfully during the crisis of 2008. The objective of this thesis was to evaluate whether hedge funds are in fact vulnerable to overall market risks and conditions, as often is denied within the definition of hedge funds. Additionally, different hedge funds' ability to give protection in the eyes of market neutrality is examined through several financial crises and comparison periods.

The main results of the performance analysis during the overall time period between 1997 and 2020 indicate that all hedge fund strategies except for "Balanced" were able to generate statistically significant and positive alpha when compared to market returns. However, during financial crisis periods, only a few hedge fund strategies were able to generate excess returns (alpha) when compared with the alpha during tranquil periods. Surprisingly, hedge fund strategies such as Distressed securities and Fixed Income arbitrage that were supposed to give protection against falling market conditions according to their definitions, resulted in the most significant losses during financial crises. Moreover, statistically significant alfas were also mainly negative. These results would imply the reality that hedge funds are not able to give adequate shelter during the times of financial crises.

Based on the performance analysis of hedge funds neutrality against market returns, we can conclude that beta coefficients of hedge funds are quite low during bullish market periods but start to increase as soon as the market conditions begin deteriorating. These findings also revealed some exceptions since CTA hedge funds produced negative beta and Global Macro along with Market Neutral hedge funds displayed diminishing values in betas during several financial crises. When analysing the correlation of hedge fund strategies and market returns, all funds except for CTA´s and Market Neutral hedge funds displayed higher correlation during financial crises

than during tranquil market periods. This would imply that hedge funds in general are not able to give proper protection against market conditions during financial crises and might even result in lower returns than presented by the market returns. These results were also supported by the findings presented by Adj. R^2 factors as a majority of hedge fund strategies had lower R-squared values during overall time periods rather than during financial crises. Similar findings are also presented by similar previous studies such as according to Billio et al. (2010), the correlation of hedge fund strategies against market returns increases substantially during times of financial crises and market turmoil. Given that hedge funds generally performed comparatively inadequately during several financial crises, is the title and description of hedged funds even justified and appropriate?

As previously mentioned, hedge fund-related data is heavily prone towards several biases due to hedge funds' voluntary reporting practices. Even when attempting to control for common biases such as backfilling bias and survivorship bias, as in this study, biases still affect the authenticity of results gained from examining hedge funds' prior returns characteristics. In addition, despite the reality that CAPM regression is simple to apply when examining the relationship between risks and expected returns, often the real empirical results obtained through CAPM can be considered as rather weak (Fama & French, 2004). However, the length of data-sample employed is generous as it includes a diverse variety of different market conditions while the time-frequency of one month is relatively short, supporting the analysis of hedge funds returns movements against market returns more accurately. Additionally, this study includes the examination of various distinctive hedge fund strategical allocations giving a comprehensive perspective about hedge funds' performance against observable market returns. As a suggestion for possible future research, the method for investigating hedge funds returns could be altered in a manner that would further assess the true essence of hedge funds problems, as the payoffs and risks are often unlike and hedge funds voluntary reporting provokes various issues. Such models are presented by Fung and Hsieh (2004) in which an APT-like model is used to define hedge fund returns with dynamic risk factors. The 7-ABS (asset-based style) factor model in question, is directly observable using market prices, hence it could provide a good benchmarking framework for identifying different biases along with returns and risks concerning hedge funds.

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